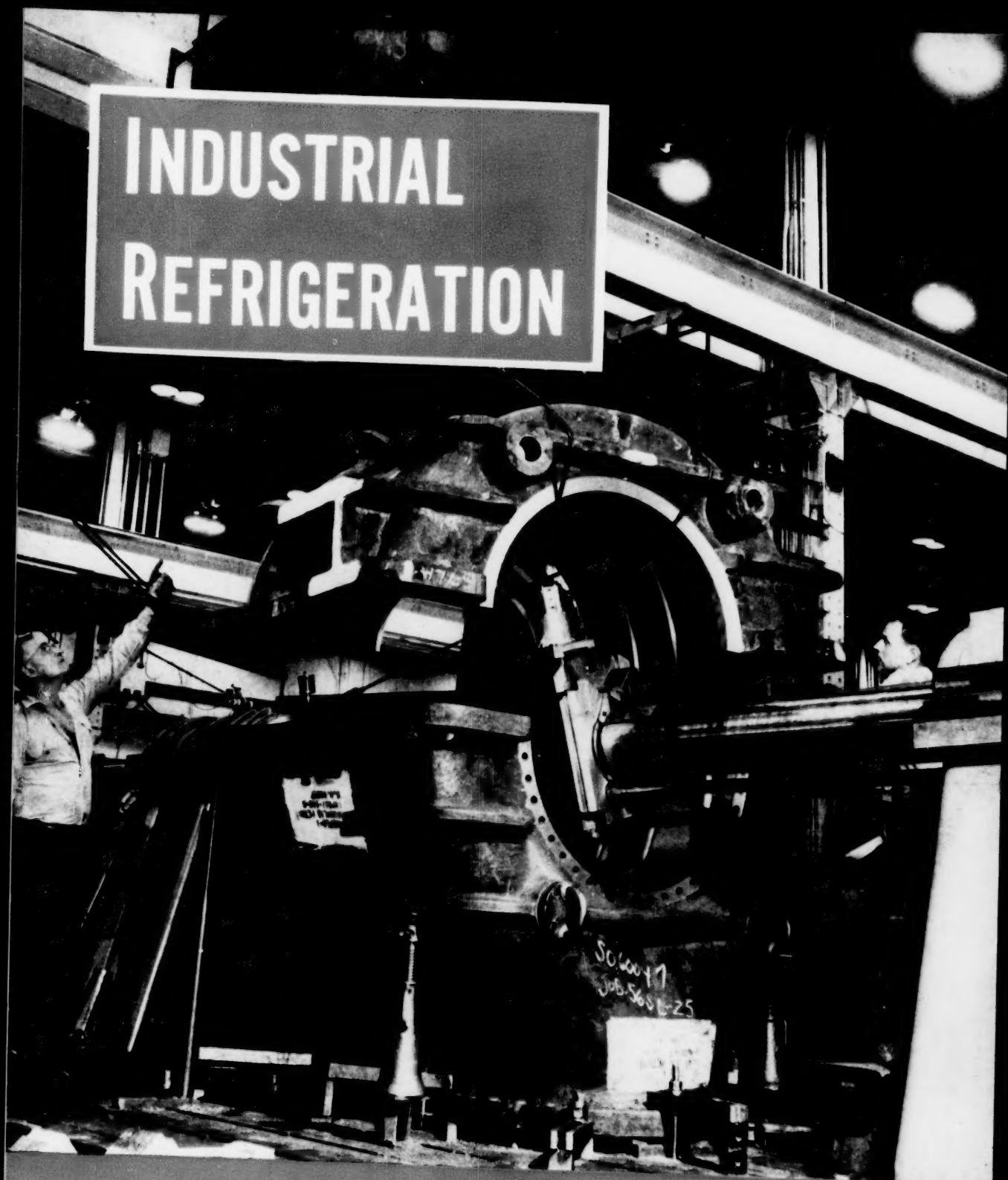
INDUSTRIAL REFRIGERATION



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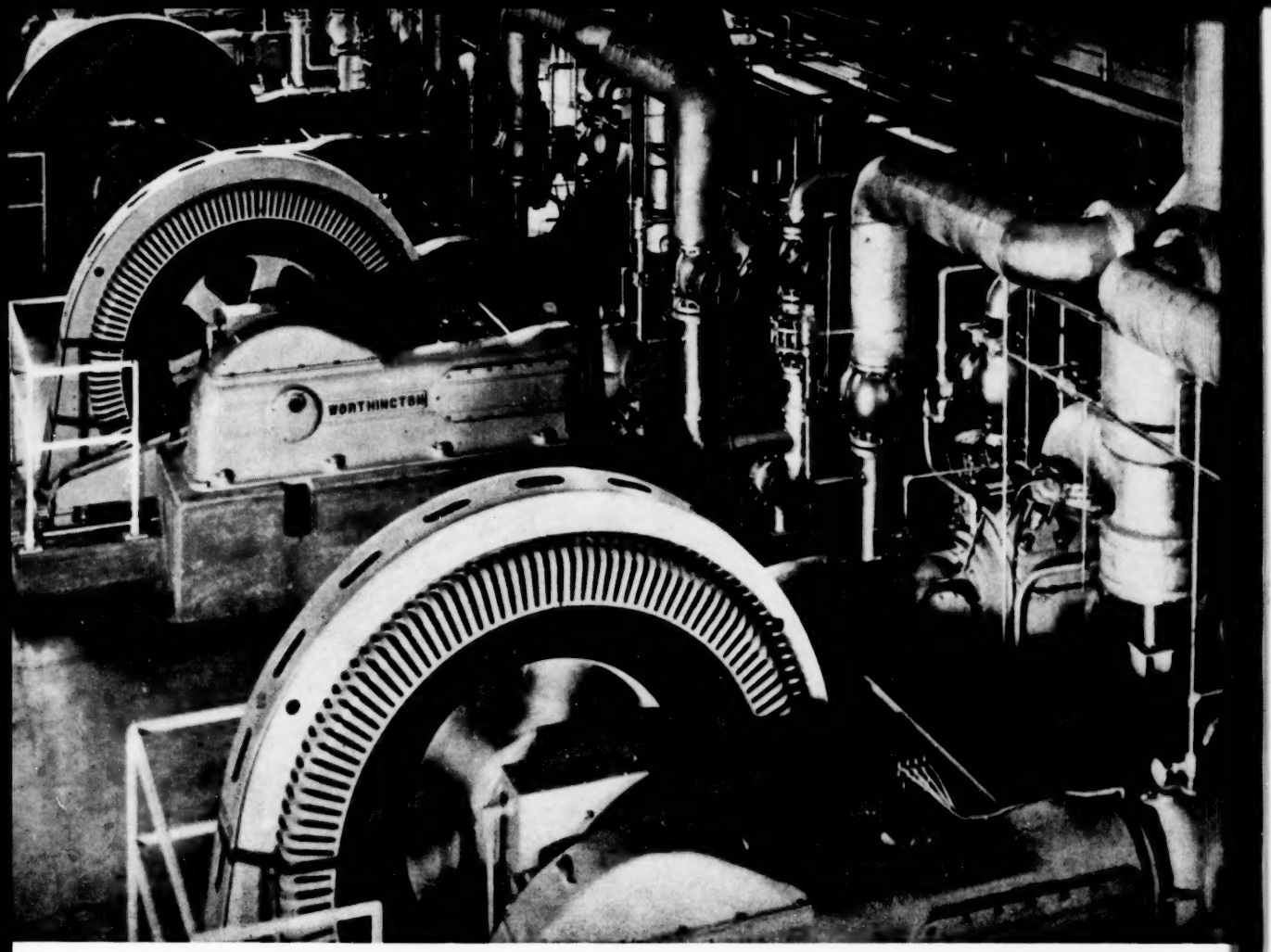
NUMBER 3

MARCH, 1958



Help your compressor give what its maker promised: CLEAN, DEPENDABLE PERFORMANCE

Use the compressor oil that almost every manufacturer recommends—*Texaco Capella Oil Waxfree.*

No matter what the refrigerant, Texaco Capella Oil Waxfree assures clean compressor performance. For example, even at temperatures as low as minus 100°F., waxout does not occur in systems where a miscible-in-oil refrigerant, such as one of the Freons, is used.

Texaco Capella Oil Waxfree has exceptionally low haze and floc temperatures. It has extra stability and a high resistance to oxidation. It is moisture-free, won't foam and is compatible with all refrigerants.

Texaco Capella Oil Waxfree is *designed* to assure clean, dependable compressor performance.

There is a complete line of Texaco Capella Oils Waxfree—all shipped in refinery-sealed containers to protect purity and quality.

A Texaco representative can help you choose the proper one. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

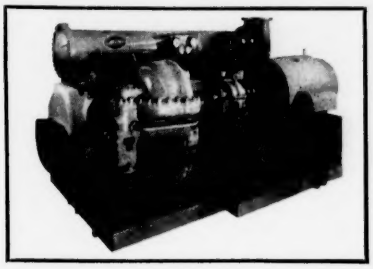
☆ ☆ ☆

The Texas Company, 135 East 42nd Street, New York 17, New York.

TUNE IN... Metropolitan Opera Radio Broadcasts Every Saturday Afternoon

LUBRICATION IS A MAJOR FACTOR IN COST CONTROL

(PARTS, INVENTORY, PRODUCTION, DOWNTIME, MAINTENANCE)

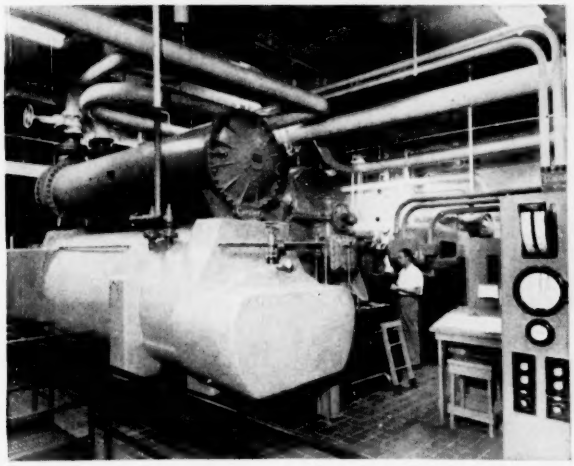


How Carrier Centrifugal Refrigerating Machines Meet a Wide Range of Industrial Requirements

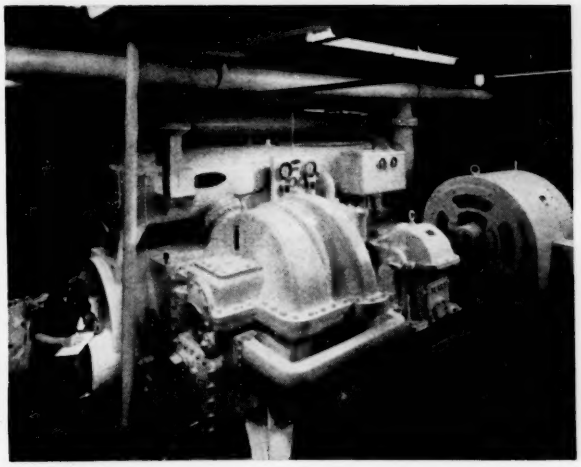
Since 1922, when Carrier developed the first Centrifugal Refrigerating Machine, Carrier has built and installed more of these machines for more purposes than all other makers combined. Over the years, Carrier has constantly refined and improved their design. You'll find thousands of them working around the clock, reliably and economically, in hundreds of installations. They are available in capacities to 4000 tons. Two typical applications are shown here—there are many more. Whatever your refrigeration needs, it will be worth your while to see how Carrier can serve them.

Call your nearest Carrier office. Or write Carrier Corporation, Syracuse, New York.

Carrier

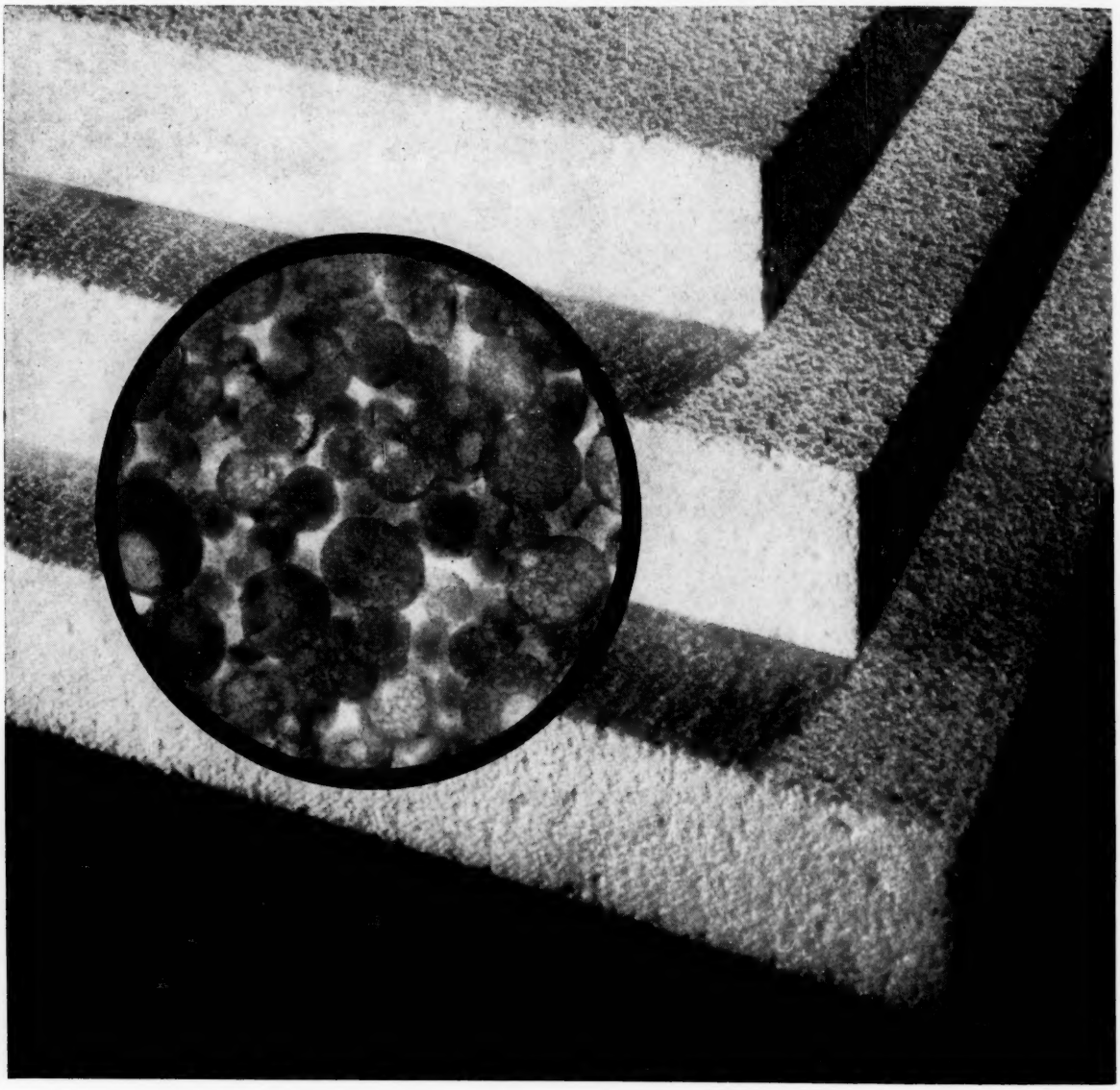


Beverages: While Carrier Centrifugal Refrigerating Machines are used to chill all kinds of beverages, their greatest contribution in this field has been in breweries with the Carrier Ammonia Condensing System. This system liquefies ammonia right in the cooler of the Carrier Centrifugal without change of pressure. It permits perfect heat balance, eliminates flash gas, prevents oil circulation in the system and lowers costs.



Food processing: From the manufacture of chewing gum and candy to the concentration and freezing of citrus and other juices, Carrier Centrifugal Refrigerating Machines are serving leaders in the field. Often the steam that is used for cooking can drive the centrifugal. Or heat required for one process can be provided by the centrifugal—operating as a heat pump—while it is serving other processes or areas with cooling.

CLOSE-UP OF A MODERN COLD ROOM INSULATION



Efficient new Armstrong Armalite

has k-factor of only 0.24 at 70° mean temperature

When it comes to insulating efficiency, few cold room insulations can equal Armstrong Armalite. The secret is the unique closed cell composition of this foamed plastic board. The lightweight, cellular structure results in a k-factor of only 0.24 (at 70° F. mean temperature). On the job, where it counts, Armalite's efficiency pays off in low operating costs, long life. Armalite is resilient, too—can be compressed on application for close fit and heat-tight joints. Other advantages of this modern insulation include negligible shrinkage at low temperatures, high strength, good moisture resistance, freedom from odor . . . all at low cost.

Those are just the high lights. For details, send today for the free folder, "Armstrong Armalite." Write to Armstrong Cork Company, 2103 Skye Drive, Lancaster, Pa.

Armstrong INSULATIONS

Industrial Refrigeration

March, 1958

Now in its 67th Year of Publication

Number 3

Vol. 134

J. F. NICKERSON, Founder

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The Cover:

HALVES OF THIS LARGE CENTRIFUGAL COMPRESSOR SHELL (12½ tons total) typify a significant trend to this type of mechanical refrigeration equipment for cooling in refineries. Temperatures of water from wells or streams is no longer adequate to carry off heat from new hydrocarbon combinations, to cause chemical reactions at today's lower boiling points and higher pressures. This unit has been precision-bored for 80 hours at Carrier Corporation's headquarters, Syracuse, N.Y., preparatory to installing impellers, which will spin with hairline clearance at speeds in excess of 900 feet per second. Weighing 35,000 pounds when fully assembled, it will supply refrigeration for a refining process at Magnolia Petroleum Company, Beaumont, Texas.

What's New

MACHINERY
APPLIANCES • PROCESSES

Swivel-Arm Float Valve By Mansfield Sanitary, Inc.

FURNISHED WITH RATCHET and thumb screw connection on actuating arm and float rod holder, a new flow valve by Mansfield Sanitary, Inc., Perrysville, Ohio, permits easy positioning of float to obtain correct liquid level. Of cast bronze construction throughout, the valve is ½-in. size, offered with either 12-inch rod and float, or chain and float (choice of plastic or copper float).

Swivel Arm Float Valve

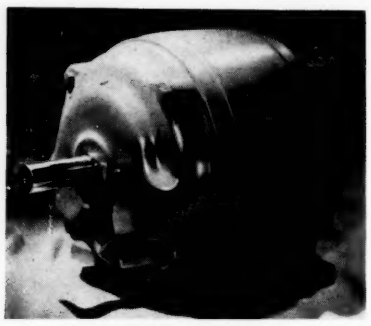
According to the manufacturer, the valve plunger is specially designed to prevent leaks and chatter. Its lower end is fitted with heavy-duty neoprene washer that screws on for tight fit, "O" ring at its center prevents seepage around stem. The entire plunger is readily-removable. Valve is recommended for installation in cooling towers and any other location where a constant liquid level is required.

Increased Horsepower In New Nema Ratings

DESIGNED and built by U. S. Electrical Motors, Inc., the new U. S. Uniclosed Motors up to 50 hp feature rugged, compact construction and incorporates a new, advanced electrical design. Savings in space of as much as 46 percent are provided with the new NEMA ratings.

New features include: advanced drip-proof design, giving greater protection against environmental hazards; a highly effective 2-way ventilation system for uniform cooling of the motor; improved asbestos insulation for better protection to windings; and a dynamically-balanced, solid cast rotor for smooth operation.

All external parts of the U. S. Uniclosed are constructed of rugged cast iron, including a new, split-type outlet box. All ball bearings are lubricated by the U. S. Lubriflush system, in which grease is injected transversely through the bearing, completely replacing old grease with new. Write U. S. Electical Motors Inc., Los Angeles 54, for bulletin F-1856.



The new U.S. Uniclosed motor

Industrial Air Filter

PERMANENT filters which do not require dismantling or removing any part for cleaning or oiling, or require a change in electrical charge, have been developed by the Farr Company, at Los Angeles. An industrial type filter developed for the railroad industry, the filtering method is that of a centrifuge. Units have been placed in various industries for removing pulverized wood, flour and cement dust. It has also been used on dusty construction jobs and in reclaiming valuable dusts in various processing industries.

Fig 1 is an illustration of a typical filter consisting of 64 fixed spiral vanes and stationary nozzles or cones employed to remove foreign particles from the air passing through the unit. The principle upon which the vane and cone work is illustrated in Fig 2. Dust laden air enters an inlet tube by passing through the spiral vanes which give it circular motion. The motion centrifuges heavy particles against the walls where the particles are trapped and dropped out through a bleed orifice. The cylinder in the center of the cone receives 90 percent of the air volume which had backed up along the surface of the discharge tube. Literature describes the tube as rotonamic.

Fig. 1—New Mechanical Type Industrial Air Filter

The manufacturer claims an average efficiency of 88 percent using standardized fine air cleaner test dirt when handling at 1000 cfm per unit, 20 x 20 in. Under these conditions it requires approximately 3⅜ inches of water gage to operate the filter. Both the efficiency and static pressure increase with air volume at 15,000 cfm. The pressure drop is 7½ inches of water. In normal application, the increase in static pressure would not be justified by any increase in filtering efficiency.

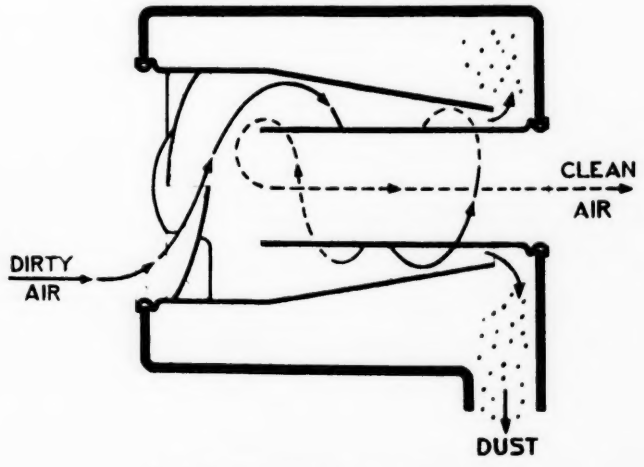
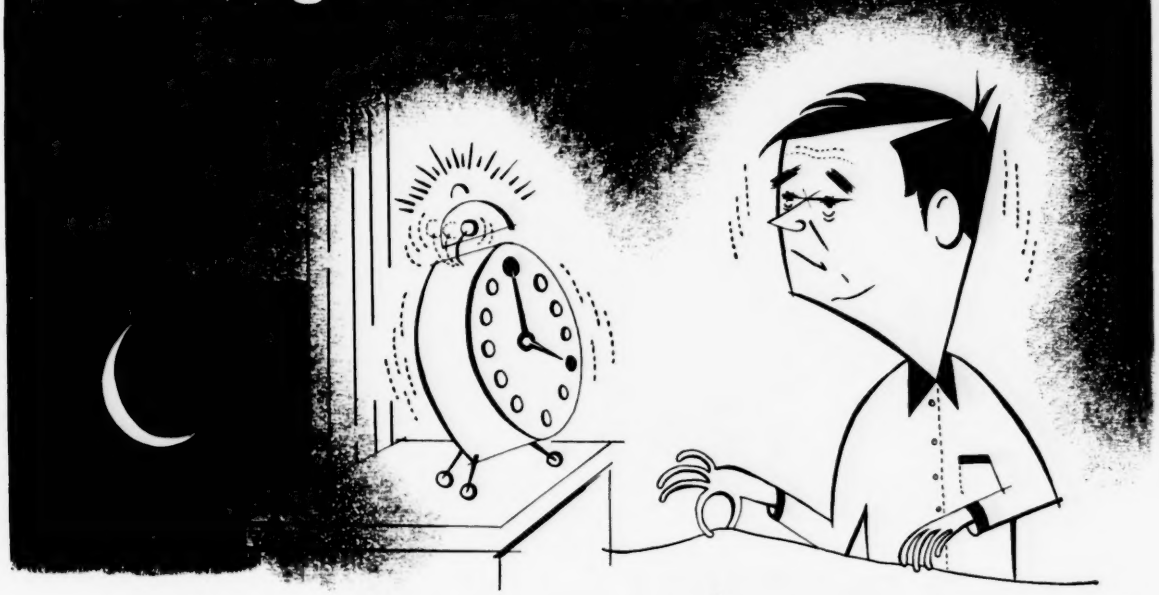


Fig. 2—Rotonamic Filtering Principles Illustrated

He Used to Get Up at 4 A.M. To Purge the Plant



. . . Before Installing an ARMSTRONG PURGER

Maybe this is an extreme case, but it's a true example of the inconvenience that is caused—in one way or another—by hand purging.

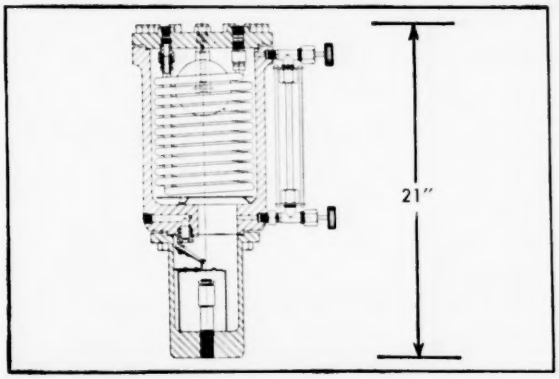
The engineer of a midwestern dairy used to get up at 4 A.M. whenever the refrigeration system needed purging, so that he could get the job done before starting up the plant for the day's work. He couldn't purge manually while the system was in operation without losing excessive amounts of refrigerant. Now, with an Armstrong purger, he can purge while the plant is in operation. And he devotes practically no time to the job—once he turns on the purger, it's completely automatic!

And he's cut operating costs, besides. The Armstrong purger takes *all* the air out of the system. Head pressures have been reduced 20 lbs., cutting power costs 10% and increasing capacity 5%. Less cooling water is consumed because the insulating blanket of air has been removed. And ammonia loss, once a costly item, has been cut to a negligible 2 lbs. per month.

The results in this case are not unusual, although the type of inconvenience may be. In case after case, Armstrong purgers have given similar benefits. So sure are the results, in fact, that you can now get one on a *30-day trial offer*. If you're not completely satisfied, your money will be refunded in full.

Why not find out more? Get the bulletin described at right—just use the handy coupon.

ARMSTRONG MACHINE WORKS
8602 Maple Street • Three Rivers, Michigan



808-P

SEND FOR BULLETIN

Bulletin No. 2212 tells more about the benefits of efficient purging; gives physical data, price, and explanation of operation of Armstrong No. 370 Purger.

To get your free copy, just fill in the coupon and mail it today.

ARMSTRONG MACHINE WORKS
8602 Maple Street, Three Rivers, Michigan

Send me a copy of Bulletin 2212.

Name_____

Clip to company letterhead and mail.

Irving R. Klein and Associates, architects

"We saved over $3,000 in construction costs by the use of Styrofoam®"—Grocers Supply Company, Inc.

"We chose Styrofoam to insulate 9,722 square feet of cooler and freezer storage space because we have found an over-all economy in its use, and a specific saving of about ten per cent in both initial cost in installation and in costs of electricity. More than $3,000, or six per cent of building costs, was saved in the construction of our new plant by the use of Styrofoam." This statement was recently made by George Levit, vice president of Grocers Supply Company, Inc., Houston, Texas.

"Styrofoam," continued Mr. Levit, "is completely effective in maintaining desired temperatures. Our cooler is kept at a constant 35°-37°, and the freezer room stays at minus ten to twelve degrees. We've had no variation in those ideal temperatures since opening our new plant."

For more information about Styrofoam, write to THE DOW CHEMICAL COMPANY, Midland, Mich., Dept. PL1705C-3.

CHECK THIS EXCLUSIVE COMBINATION OF PROPERTIES

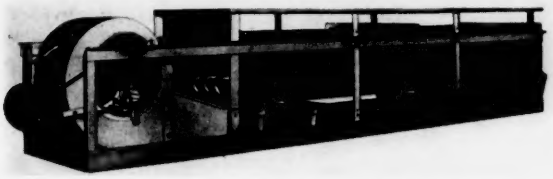
STYROFOAM*
FIRST IN PLASTIC FOAM INSULATION
* Styrofoam is a registered trade-mark of The Dow Chemical Company

Insulations	Low "K" factor	Superior water resistance	High compressive strength	Light weight	Superior resistance to rot and vermin	Easy handling and fabrication	Low-cost installation	Lowest cost per year service
STYROFOAM	●	●	●	●	●	●	●	●
A		●	●		●			
B	●			●			●	
C	●		●					

YOU CAN DEPEND ON DOW

Coldjet Low Air Velocity Space Cooler

NEW Model of the widely accepted ceiling-suspended Coldjet space cooler has just been announced by Imeco, Inc. Known for the ease with which it is installed, the newer cooler is even simpler to apply because headers are placed on the



Ceiling Suspended Space Cooler

end away from the blower section. Other features are: an improved motor mounting, making belt adjustment extremely simple and the whole motor more accessible for easy maintenance; a larger diameter blower, requiring lower horse power consumption for the same cfm, and giving quieter operation.

Equipment Desirable For Meat Packers to Reduce Shrinkage

Low air velocity Coldjets have been found especially attractive to meat packers because they hold meat shrinkage to a minimum, fit between and/or overhead of rails, and eliminate drafts and objectionable noise. They are furnished in eight sizes, suitable for numerous refrigerants, and offer either galvanized iron or stainless steel casings. Details on the new Coldjet model can be had from IMECO, Incorporated, Chicago 18, Illinois. Ask for Bulletin 358.

New Temperature Control

A NEW type thermoswitch provides adjustable temperature control for effective protection against icing of low temperature and freezer doors. The thermoswitch is used

Closeup of Thermoswitch for Freezer Door

It takes practice to do this WELL!

Of course we're *good* at pipe-bends, after specializing in them since 1883. Each one of those 75 years has contributed something to the superior performance of today's

NATIONAL *Refrigeration Coils*

Progressive engineering and expert production, smooth bends and skilful welds and accurate measurements delivered . . . this is specialization that *pays off* in lower maintenance, higher efficiency, greater longevity.

Whenever *you* need coils, why not send for our free tracing-chart? It will simplify your specifications, whether for zig-zag or nested box or conical or round-flat or reducing coils. — NATIONAL QUALITY also guarantees effective service in HEATERS, CONVERTERS and HEAT-EXCHANGERS.

NATIONAL QUALITY

NATIONAL PIPE BENDING CO.

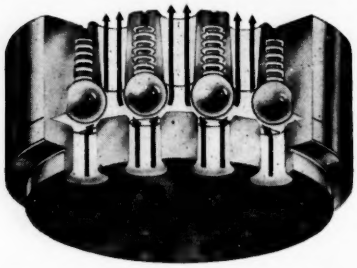
Established 1883 162 RIVER ST. • NEW HAVEN, CONN.

PERFORMANCE-PROVED!

New BALL VALVE

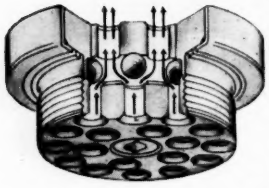
DISCHARGE AND SUCTION VALVES INCREASE THE PERFORMANCE OF ANY COMPRESSOR—OLD OR NEW!

"BV" DISCHARGE VALVES



Actual tests conducted by a leading independent research organization* prove that the New Ball Valve *passes 26% more gas!* In operation, users report amazing increases in performance when they install Ball Valves—and not one report of valve failure or breakage in operation! *Name on request.

"BV" SUCTION VALVES



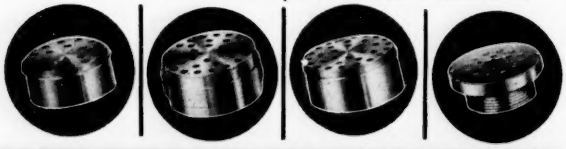
In the Ball Valve, multiple steel balls replace the flat "plate" or "poppet" — resulting in less resistance, better seating, far greater life and improved performance. New "BV" Standardized Suction Valve Assemblies, available for most compressors, allow complete standardization of your suction valves, regardless of the number of different makes of compressors that you have in operation.

Can Be Installed in 3 Minutes

Easy to install, without drilling or tapping. "BV" suction valves are simply screwed in, then locked in place with special locking ring. Removal for inspection is just as quick and easy.

For information on improving the performance of your compressor, send us the name, bore, stroke, speed and serial number of your machine.

BALL VALVE CO.
5512 Oak Street • Kansas City, Mo.
Some franchise territories open. Write for information.



VALVES CARRIED IN STOCK FOR LEADING HEAVY DUTY COMPRESSORS.

with the Jamison Cold Storage Door Company's Frostop which provides a temperature above the dew point at point of gasket contact.

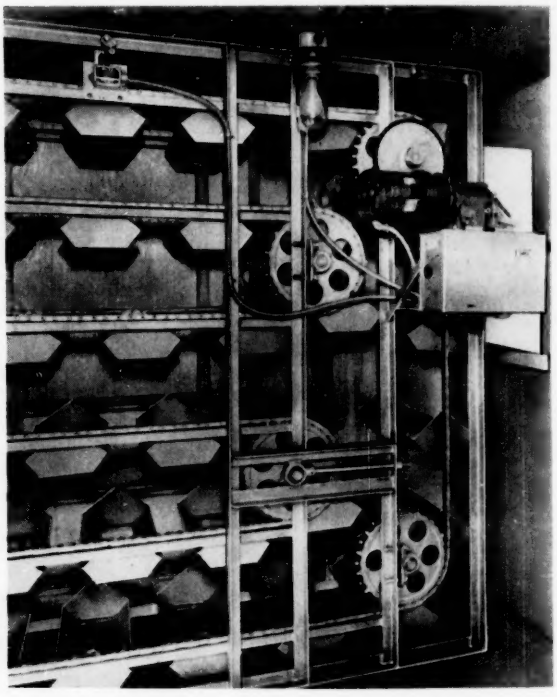
The new control is said to provide foolproof operation along with maximum protection as it maintains temperatures between 60 and 120 F. The 60 F minimum temperature prevents condensate from forming in the cable channels, frame and sill and subsequent icing while the 120 F maximum temperature protects excessive temperature damage to frames and gaskets. The temperature control has no on-off switch, thereby, eliminating accidental or unauthorized shutoff.

This additional safety factor, in combination with an improved glass and silicone rubber insulation on the heating wires, has gained Underwriter Laboratory seal for Frostop's use on a wide range of doors, including package passing, horizontal sliding and walk-in doors.

For further details, write the Jamison Cold Storage Door Company, Hagerstown, Md.

New Basket-Vend Conveyor For Ice

SOMETHING new in ice conveyors has been introduced in the 1958 Polar line, by Refrigeration Engineering Co., Montgomery, Minn. It's the Polar Basket-Vend Conveyor for 7-1/2 to 15 lb bags of cubed or crushed ice. Designed with high capacity of bags in vending position, the basket-vend conveyor is available in all sizes, for installation in Polar Stations, or in present storage rooms.



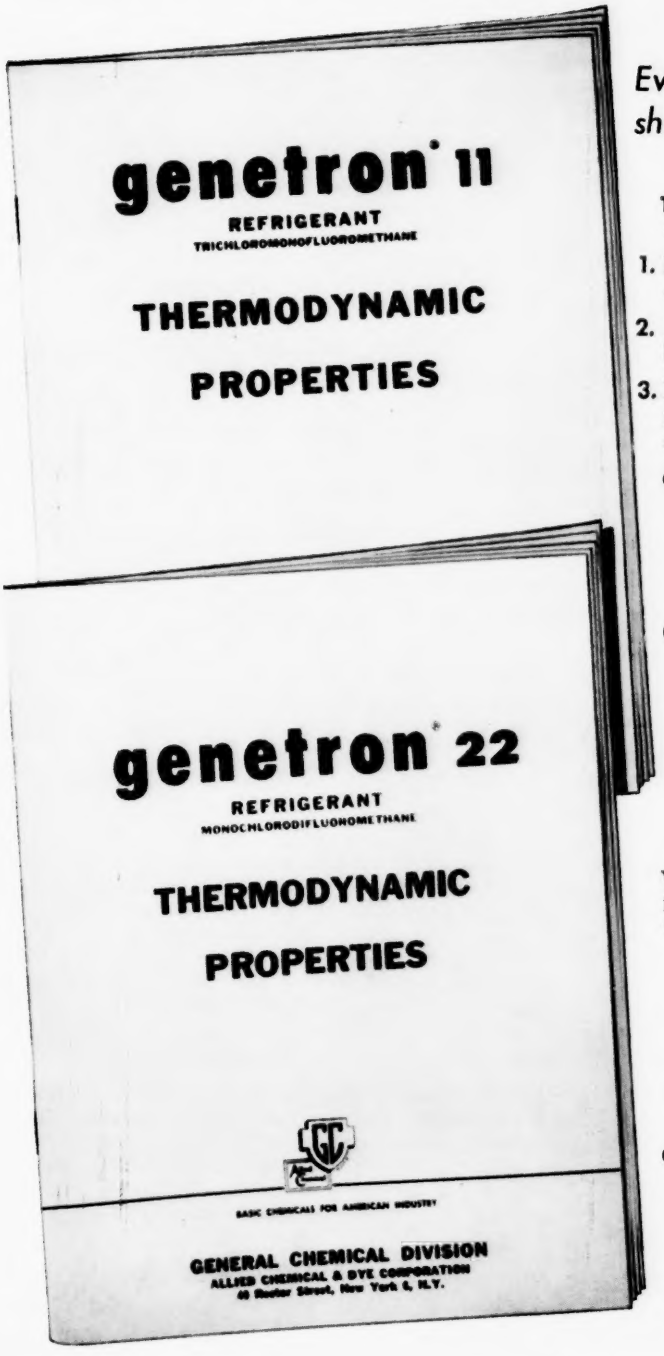
Interior mechanism of new basket-vend conveyor.

Fool-proofness is the outstanding feature of this conveyor. Each bag travels in its own protective carrier, or basket. Loading does not require spacing or accuracy on part of the operator, as the bags are never shifted in position, nor dropped from belt to belt. Noise and tumbling are eliminated. Any empty baskets are by-passed because the delivery switch is on the chute, not on the conveyor.

Each ice sale is recorded by a counter which cannot be reset. The counter, with all conveyor starters, is enclosed in a condensation-proof metal box. National Rejectors coin mechanisms are used, which take change in nickels, dimes, and quarters. Descriptive literature, prices, and further details may be obtained by writing to the manufacturer, Refrigeration Engineering Co.

NOW! from General Chemical Research

NEW THERMODYNAMIC TABLES ON TWO IMPORTANT REFRIGERANTS



Every Refrigeration Engineer should have this important data!

These new tables, 32 pages and 36 pages respectively, offer three important advantages:

1. Electronic computation, completely eliminating computational inaccuracies.
2. Best available data, including new thermal data based on spectroscopic measurements.
3. Expanded range for saturated and superheat properties and smaller temperature and pressure intervals.

Genetron 11— Saturated Properties:
−40° to 298°F
in 1°F intervals

Superheat Properties:
0.1 to 300 psia

Genetron 22— Saturated Properties:
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in 2°F intervals
and
−50° to 150°F
in 1°F intervals

Superheat Properties:
0.1 to 300 psia

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(AMMONIA, FREON, BRINE)

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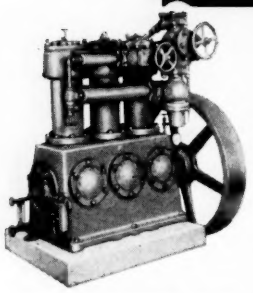


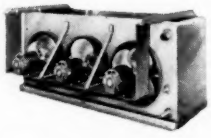
HOWE COMPRESSOR DS-26
Sizes: 25 to 50 tons

HOWE POLAR CIRCLE COILS
for freezer storage service

ECONOMIES GAINED through one-source buying are yours when you specify dependable HOWE equipment. Correctly engineered to individual plant application and built in Howe's custom-order fabrication shop, you get highest efficiency at lowest possible operation cost. Volume prices on small quantities are yours due to our shop flexibility. Firm delivery dates.

NEW HOWE 3-FAN UNIT COOLERS
Heavy Duty—High Tonnage

The new RAPID FREEZE units are especially designed for blast freezing and freezer storage of all kinds of food products.



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PRESS BRIEFS

City Products Net Increases

THE quarterly dividend of City Products Corp., Chicago has been increased from 62½ to 65 cents a share. At the same time the company reported increased earnings. The new dividend will be paid March 31 to stockholders of record March 12.

For the nine months ended December 31 the company reported net earnings of $3,675,944, equal to $2.95 a share, compared with $3,663,382, or $2.94 a share in the like period a year earlier. Sales for the nine months rose to $77,886,214 from $75,403,913 the year before.

William J. Sinek, chairman, said that anticipated earnings for the fiscal year ending March 31, 1958, will be approximately the same as the $4,587,468, or $3.68 a share, earned in the year ended December 31, 1956. The company has changed its fiscal year to end March 31.

The Federal Cold Storage Division of City Products Corporation has taken over a refrigerated warehouse located at 4057 S. Halsted Street, Chicago, Illinois, which has a capacity of approximately 1,500,000 cu. ft. This acquisition gives City Products a large cold storage facility in the Chicago area, which will be extremely beneficial to the company in their wide-spread operation, according to a February release by the firm.

Storage Firm Files Suit

A SUIT for $667,431 has been filed in Federal district court by Merchants Ice & Cold Storage Co., Richmond, Va. against the City of Richmond as a result of a January 16 explosion in the firm's cold storage plant that took seven lives. In the suit, the company charges the blast, which rocked a large area of downtown Richmond, was caused by natural gas the city negligently permitted to escape from a line adjacent to the warehouse. Merchants Ice & Cold Storage asks $642,421 in damages and an award of $25,000 as a result of claims made against the company by the family of Charles R. Gray, one of those who died in the explosion.

New York City Refrigeration Code

AN ordinance recently signed into law by New York City modernizes provisions of the City Refrigeration Code and includes a number of changes expected to result in savings and benefit to hotels. The new law reduces the annual fire department license fees on many systems, including air conditioners and water coolers; eliminates use of licensed operators on all Freon systems up to 50 hp, where systems were installed on or after June 1, 1957; and makes technical changes in installation requirements.

Fire Destroys Ice Plant

FIRE of undetermined origin destroyed the old Russell Ice plant building at Picher, Okla. The two-story frame building was vacant. George Russell, son of the late George Russell who built the building, said that it was erected in about 1917 and was in use until two years ago.

Old Warehouse Burned

THE old Huston Cold Storage plant, Lockport, N.Y., was burned recently, with estimated damage of $100,000. The three-story stone structures, built in 1838 was originally a flour mill. Later it was remodeled for a cold storage warehouse.

In the Spotlight

GUEST SPEAKER at a recent meeting of the Central States Frozen Food Packers Association was Dr. H. C. Diehl, Director of TRRF. Diehl, sizing up present marketing and distribution problems of the industry, made two particular points for consideration by his audience. One, a factor directly under control of the packer in its first phase, is that of quality. Quality is the basis on which the frozen food industry has been established with the consumer. In its second phase Diehl said quality could be preserved by packers encouragement that transportation, storage, distribution and retailing meet the findings and recommendations of Time-Temperature-Tolerance. The second point was that of an industry–wide self-policing program to see that TTT requirements are maintained. See page 13.

PRACTICAL ENGINEERS are not alone in their misunderstanding or vague knowledge of water vapor behavior above 32 F, let alone below freezing temperatures. Questions raised from time to time by management and supervisory personnel prompted INDUSTRIAL REFRIGERATION'S technical department to suggest Humidity as an NAPRE annual meeting topic, in 1957. Outgrowth of that recommendation is the article on page 18.

Speaker (author) selected by the Association's Educational Committee was Norman Sharpe, an Associate of Dean H. P. Hayes, Conductor of the Question Box. In his talk, Humidity and Its Control, Sharpe has described basic psychrometric data for study by responsible personnel of refrigerating enterprises. Other papers on practical humidifying and dehumidifying applications, such as chemical and mechanical devices, use of refrigeration for controls, descriptions of equipment, and industry practices will follow.

AIR CONDITIONING of entire manufacturing plants continues to be a fast growing application. Officers of the nation's leading manufacturers of such equipment point out industrial plants are third only to those installations in new and existing office buildings. On page 18 is a short article on the recent installation in a staple and fastener manufacturing establishment.

BASIC INFORMATION essential to a study of the "Why" behind the efficiency of multi-stage systems, was given in the first installment of an article by Professor W. F. Stoecker in the February issue. This month the Professor continues his article, previously presented at the 48th Annual Meeting of NAPRE. See page 26 for his explanation of how multi-stage systems can be analyzed by making heat balances and flow balances about the vessels involved. In addition to showing how the systems are analyzed, Stoecker points out other incidental practical advantages which are derived in the way of lower maintenance costs.

MANAGEMENT of companies using industrial refrigeration and air conditioning will do much toward long-range reduction of operating costs, simply by interesting their engineer personnel in NAPRE. So writes Frank L. Chase, Building Supt. Hibernia Bank Bldg., New Orleans, in an article on page 32. Chase should know. He has been chief engineer as well as building superintendent, for the 20-odd storied building and tower which is "the Empire State Building of New Orleans". All of his engineers operating the many hundred tons of air conditioning in this navigational landmark, are NAPRE members.

What Value Associations

FEW business activities contribute so significantly to our country's economic fabric, as public refrigerated warehousing. It is the very heart of the world's finest food distribution system and a major factor in making Americans the best-fed, healthiest people in the world.

Intelligent development of refrigerated storage facilities by the warehouse industry has–over the years–cut down the cost and expanded the volume of foods which move in the nation's channels of commerce, putting within reach of every citizen the multitudinous products of American agriculture at all seasons of the year.

Public Warehouses Provide Economic Stability

The products of our fields and orchards flow to the nation's many distribution centers, where these perishables are carefully stored in public refrigerated warehouses, under scientific temperature and humidity control, to await consumption. Protecting our producers from disastrously low prices during the season of production, and protecting the consumer from high prices during the season of non-production, these dynamic food terminals have a leveling effect on food prices–and our National economy.

The growth of the refrigerated warehouse industry has paralleled the growth of our nation's food production. Consumer demand for California vegetables, Florida fruits, western meat and other perishables from every part of the United States–as well as the tremendous growth of Frozen Foods–has caused the refrigerated warehouseman to build millions of cubic feet of additional freezer storage space throughout the nation.

7 Billion Pound Capacity

This expansion represents added service to refrigerated warehousing industry's many customer industries which store some 25 different varieties of perishables in the more than 750 public refrigerated warehouses across our nation.

These warehouses are capable of storing over seven billion pounds of food at one time–a fact which points up the significant part they play in our vital food distribution system.

Note: The above comments are especially timely in view of the annual meeting of AWA-NARW to be held in Dallas, Tex. March 10-13.

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Alco Evaporator Pressure Regulators accurately maintain evaporator pressure in either a single or multiple system, guaranteeing highest evaporator efficiency regardless of load changes.

Call your Alco Wholesaler—
Write for (Specifications) Bulletin #183-57.

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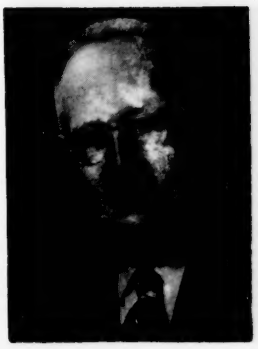
The one complete line of refrigerant controls: Thermostatic Expansion Valves • Refrigerant Distributors Solenoid Valves • Suction Line Regulators • Flooded Evaporator Controls and Reversing Valves

By DR. H. C. DIEHL



Quality and Temperature All Along the Line Are "MUSTS" in

Frozen Food Industry

AMERICANS, often thoughtlessly devoted to that modern fantasy that motion is always progress, have been compelled recently to stop, look and think before they continue to leap onward in the contented abandon of prosperity and progress. Their material advancement in a half century has been astounding. So long as conditions remain favorable, such progress will flourish, and accelerate. This is one of the laws of human action.

But hypnotized by such progress, the human being also becomes an opportunist occupied with the daily demands of his on-rushing existence. He has no time to do more than keep the machinery of his daily progress from bogging down. He has little time to think of where he is going ultimately; he is concerned only with going somewhere.

It is not surprising then that the frozen foods industry seems also to be affected by some of the apparent deficiencies of national life. It, too, must take stock of past actions, present position and the future.

Product Is This Industry

Perishability of frozen foods is their greatest asset, as well as their most troublesome deficiency. The very fact that frozen foods are so perishable in relation to environment, notably temperature, is in a sense, also the reason for their desirable qualities. Basic reasons for success of frozen foods is product quality, protected by unanimous and continuously adequate refrigeration.

What is it that makes an industry possible? It is the merchandising of either product or services. All industrial action is accessory and contributory to that objective. For frozen foods, it is *product-quality of product*, convenience of product, nutritional properties of product, eye and appetite appeal of product.—But always the *product*.

The Frozen Food Industry doesn't sell systems of freezing, transportation, warehousing or distribution. It sells *product*. Therefore, when a product is too often or too greatly abused by carelessness or ignorance of essential facts, that product will ultimately fail to hold its place on the public interest; no matter how attractive the advertising, no matter how clever the merchandising gimmick, no matter how initially promising the newness of its potential market.

Realities of life always catch up with deeds of people, or their misdeeds and wrong ideas. In free competition others more acceptable take their place. People also remember unpleasant experiences longer and more acutely than pleasant ones; and seldom subject themselves a second time. Frozen foods have a memory for good and bad treatment.* In that respect, frozen foods act like people. Not all frozen foods have the same sensitivity to temperature change—again they act like human beings.

But so long as the requirements of practicability prevent an individual environment for each product during its movement from produce to consumer, the Frozen Food Industry must provide environment which will give the most feasible protection to all frozen foods of economic importance. Obverse of that statement: Those foods which cannot, after every technical device has been exhausted, retain essential properties of quality in a commercially practicable, but also adequate, merchandising procedure cannot long remain on the roster of foods, preserved by any particular method. This fact is certainly true for frozen foods.

To be important in the national food economy, it is not necessary that freezing preservation include all foods in its roster anymore than all foods must be heat-processed to justify the great value of the canning industry; or some day, ion-sterilized foods for justifying the irradiated food industry.

Responsibility Continues Long After Introduction

Opening up the vast consumer potential for prepared, convenience frozen foods, also required an acceptance of responsibility with regard to such foods. Improper temperature environment for such foods may not only affect quality adversely, but may have potentially dangerous implications for public health and consequently for the entire frozen foods industry. This does not imply that such foods are not properly prepared and adequately protected, and very desirable as convenience and specialty items. But such foods do require definite temperature and sanitary care. Unfortunately they can be very satisfactory media for micro-organisms which affect public health if environmental conditions of their distribution or their uses are not right.

It is indispensable (though not often done in this era of progress-by-notion) that when an important program is initiated in any field, all parties to the project think the problem through as completely as possible to the ultimate objectives, including all essential requirements for success.

If that were done, essential costs would be taken into consideration in the beginning, and the pricing developments adjusted accordingly. More often another sequence follows. The essential product protection by services and packaging are ignored or given lip service, and then when their indispensability is manifested as a basis for long range success, it is deemed impossible to do the right

Condensation of a speech given at the Central States Frozen Foods Ass'n. at Chicago, Ill. Jan. 15, 1958.

* From the USDA, WURDL, T-T-T investigations and reports; 1951-19___.

thing. The product will not stand the cost—that is the excuse!

With frozen foods wholly dependent on quality maintenance because of their perishability, such evasion of responsibility can only lead to eventual trouble, and perhaps even disaster. There is no use in frozen food industrialists kidding themselves; they cannot kid the public which they have educated to demand quality. If another food product is definitely spoiled, the customer is likely to return indignantly to the place of purchase and demand a replacement of product or his money back. It is an unpleasant situation, but at least one can deal with it, face to face.

Industry Loses Customers

But when frozen foods lose quality to the degree where a consumer, comparing them with other foods is not satisfied, that person is not likely to return to the store to complain. That consumer simply quits buying that, and perhaps other, frozen foods. This industry has lost a potential consumer without even knowing that fact.

This is the type of quality degradation which still is all-too-frequent. It results from abuse to frozen foods in the pipelines of food distribution. This type of quality degradation results from a succession of people, dealing with frozen foods—from producer to consumer—carelessly or ignorantly assuming that when frozen foods warm up here and there, it doesn't matter, so long as the product temperature is brought down to Zero F. again. Admittedly the latter is desirable to arrest the deterioration tendency which has set in, but it only can stop the damage.

Even at 0 F, some changes slowly occur. That temperature is a practical compromise, although there is presently a tendency to seek lower commercial environment temperatures and economic feasibility should determine how far that trend should go, because there is a sensible limit. All vitamin content in frozen food cannot be retained in commercial usage. Such foods are not consumed only for their vitamin content. Beyond reasonably good diet, vitamin requirements are better (and cheaper probably) obtained at a pharmacy.

In discussing environmental effects on frozen foods, it must be remembered also that a frozen food cannot be any better in quality after freezing than the original quality. Hence, while temperature and packaging protection are stressed, responsibility of the packer cannot be ignored in quality maintenance policy. The pressures of a price-conscious economy (perhaps better called a price psychotic economy) may suggest at times that quality can be reduced with no one being the wiser.

Distribution Task Complex

Frozen foods have a memory. Every misdeed affecting frozen food quality is accumulated in the product. Producers, transporters, warehouses, distributors and retailers all have joint responsibility in these matters and there is no constructive reason, except to establish facts, to point an accusing finger exclusively at one area of frozen food production and distribution. If the area of wholesale distribution and retailing seems, in factual surveys, to have greater deficiencies at the moment, then it is also true that the protection of frozen food in these areas and in the hands of the consumer, is a complex and difficult problem.

By understanding and cooperative action this problem can be solved, now that the industry has the necessary facts about frozen food behavior from the USDA T-T-T investigations. Time and Tolerance and control of human temper-Temperature is also necessary to rectify those deficiencies, which are known to exist. Avoidance of responsibility and any attempt to shift blames rather than correct present deficiencies and past mistakes, can only result in harm to all.

Free competition is a wonderful privilege of our economy, but unwise pursuit of price cutting objectives can also kill off the very benefits which free competition is supposed to provide. When cheapening of prices leads to degradation of quality either initially or along distribution paths in an industry which has only product to sell, then the outlook is not pleasant to contemplate. Cheapening of product prices makes impossible the adequate protection of that product, especially an environment-sensitive product, such as frozen foods. Wherever costs of services can be reduced by increased efficiency, obtained through solid modifications of practice, such reductions should be sought. But don't throw out the baby with the bath water.

Lower Quality Product Not To Be Tolerated

Frozen foods have a memory. The industry, too, should have memories of past experience. Every time the industry fiddles with the quality of frozen foods, whether by initial disregard or subsequent environmental misdeeds, they gamble with the future of the industry. The industrial sales currently grow, but is it not true that they increase presently more in relation to population growth than in that manner which would indicate increased acceptance by the public? If that is so, it is important that the industry determine the reason. Frozen foods have a memory; the consumer has a memory, too!

Not long ago, many people were much disturbed by the overly-dramatized, allegedly imminent impact of

food irradiation upon all other forms of food preservation, especially upon preservation by refrigeration. Happily, facts finally have taken precedence over fantasies and it can be seen more clearly now the probable function of irradiation in our food economy. So also, will time and facts place in right perspective an even more likely and more pressing future competitor of frozen food—high-temperature short-time sterilized foods (both of which foods, by the way, may generally require refrigeration in the cooler range).

These technological advances will not destroy frozen food potential. Only the Frozen Food industry can do that by refusing to recognize the facts.

Two Industry Developments Set The Stage For Tomorrow

Where does the industry go from here? Mutual response that leads to cooperative, consistent and determined action to change those deficiencies of procedure which need changing, should be stimulated. Specific actions cannot be predicted but *put first things first;* namely, that the consumer be pleased and benefitted by frozen foods, and return again and again for more.

To give motion to such action, two developments have taken place:

First, almost 7 years ago, there came into being the USDA T-T-T investigations. This unique research enterprise has cost a sum approaching in the aggregate two million dollars. Reports are in technical language, as they must be, but they hold the prescription for success of the frozen foods industry. Until these prescriptions are used in practical application, there are no results.

Therefore, in 1957, there was formed a voluntary inter-industry Task Group, composed of representatives of all facets of industry concerned with frozen foods. The National Association of Frozen Food Packers has given constructive clearing-house service to make this action possible. This Task Group's objective is to bring into action on the firing lines of frozen food distribution by many devices and continuing effort, the T-T-T research prescriptions.

Broad-gauge understanding of the frozen foods potential must be joined with harmonious and intelligent cooperation in mutual interest, in this continuing Task Group effort, if the full potential of this action is to be realized. It is not a one-shot enterprise that can be done half-heartedly; it is an all-out effort, requiring fortitude, thought and determination; and then some more of the same.

This is one of the roads which the industry travels from here!

Support More Research

It has long been evident that the Frozen Foods Industry, by some form of intelligent cooperation, must, in its own interest, give more consistent support and interest to those scientific investigations (Federal, trade and industrially—endowed) which have vital effect on its present and future. There has been, in the past, inadequate industrial encouragement, to say nothing of moral or financial support, given to such constructive undertakings.

It is not likely that Sputniks will jolt this complacent non-concern, but the situation in the frozen food industry has striking similarities with present national posture which the industry would do well to ponder. Determination to do that which will insure the future of the frozen foods industry must come from the industry itself; not in a day to day concern over minor developments, but in a long-range, realistic appraisal of the industrial potential.

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That's another road this industry should travel from here!

Retail. Transport Facility Slated For Improvement

Physical facilities for transport, distribution and merchandising frozen foods, despite laudable and consistent effort by all concerned still have large gaps of unachieved development. This is especially true, some people believe, in the display and merchandising cabinets now available. Dollar sales of frozen foods in relation to floor space occupied are still not in an ideal position, and floor space-selling efficiency is one of the most important aspects of food merchandising, of course.

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Progress Up To Industry

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Bostitch Provides For Completely Air Conditioned Plant

DESCRIPTION is revelation. And a description of the completely new Bostitch (staples and fasteners) plant reveals the same long range thinking in connection with the modern air conditioning system, which guided the over-all design and development of this beautiful new plant at East Greenwich, Rhode Island.

Planned with a serious anticipation of what is to come, the building is not merely an enclosure of space; it is a highly successful integration of structure, function, and enclosure. It is constructed to serve an industry, to please management and employees alike, and to express a confident, realistic attitude toward future development.

Management, architects, engineers, and contractors cooperated to fulfill to the greatest degree of satisfaction, the requirements which provided efficient arrangement for the manufacturing process, balanced distribution of architectural elements, and maximum "controlled" atmospheric comfort the year 'round.

The Charles T. Main, Inc., Boston, Mass., were consulting engineers. Charles P. Blouin, Inc., Heating & Ventilating Contractors, Cambridge, Mass., handled the sheet metal work. Working together, these organizations provided a modern addition to an old New England landscape, with a highly efficient heating and cooling system.

Major System Components Number Over Seventy

Within this plant, which encompasses over 400,000 square feet, there are installed more than seventy Dunham-Bush heating and cooling units, compressors, and heat exchangers of various sizes and capacities.

The Stapling Department is completely heated and air conditioned by five individual systems, each system comprised of several Dunham-Bush units. However, this portion of the manufacturing area was not the only plant sections given consideration with regard to promoting personnel efficiency. Executive offices are air conditioned. Engineering and drafting departments were given the same consideration. Employees' cafeteria was comfort cooled and provisions were made for air conditioning the manufacturing space (those areas outside the Stapling Department) in the future.

Bostitch's new plant is an example of the use which is being made of modern flexible heating and cooling methods—effectively meeting today's demands, and readily adaptable to those of tomorrow.

Individual Systems Detailed

System No. 1 serving the Stapling Department, consists in part of a Brunner 100 hp compressor, a Dunham-Bush horizontal air handling unit rated at 18,000 cfm at 500 fpm coil face velocity, and a 12,000 cfm horizontal air handling unit. Also serving the Stapling Department equipment are systems No. 2, 3, and 4, all identical, each system having a Brunner 100 hp compressor connected to two Dunham Bush horizontal air handling units, one 24,000 cfm and one 12,000 cfm.

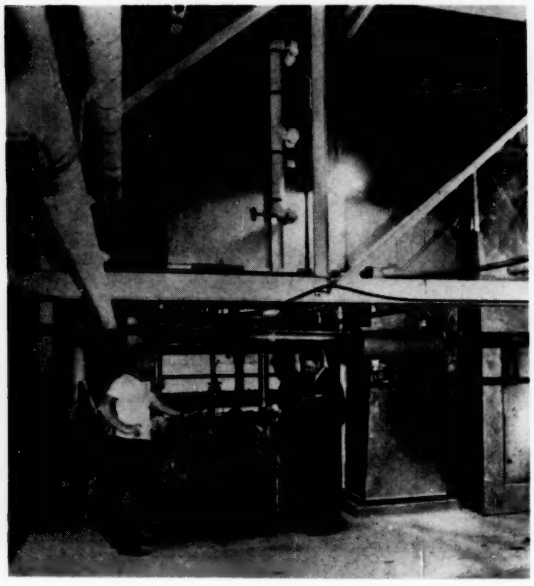
Additionally, each system has a Dunham-Bush inner-fin evaporative condenser rated at 90 tons, and a Heat-X inner-fin heat interchanger. System No. 5 like No. 1, has a 100 hp compressor hooked up with two horizontal air handling units; 18,000 cfm and 12,000 cfm.

Horizontal air handling units are installed suspended from the ceiling, leaving more floor space for production or other equipment. The five system climatic regulating network composed of quality heating and cooling equipment is capable of delivering the proper kind of atmospheric comfort at any time.

Comfort Air Conditioners

The tastefully appointed executive offices are air conditioned with a 75 hp compressor, a Dunham-Bush multi-zone 10,000 cfm and a multi-zone 24,000 cfm air handling unit, and a 75 ton evaporative condenser.

Proper atmospheric conditions in the Engineering and Drafting Department are provided by a 75 hp compressor, two horizontal air handling



At left, one of eight 75- and 100-hp Brunner compressors employed in the multi-system air conditioned Bostitch plant. Above, suspended units placed in the roof truss over manufacturing area, supply cooling for comfort conditioning system serving executive, engineering, and other front office areas.

At left, plant executive eyes one of the 24,000 cfm air handling units which provide steam heated air circulation to the manufacturing area. Units are equipped for a later hook-up to a direct expansion refrigerant system which will afford air cooling in areas which may require it. At RIGHT, one of the shipping and receiving doors, where blow-down unit heaters are installed to provide heating during low temperature winter operations.

units, 12,000 cfm each, and a 75 ton evaporative condenser.

In the excellently furnished, daylight pervaded cafeteria, from which the view extends out over spacious lawns to the highway below, employees eat in air conditioned comfort created by a 75 hp compressor operating at 50 percent capacity on a horizontal air handling unit of 12,000 cfm.

The main manufacturing space, which contains the largest single area, is serviced by 24 horizontal air handling units of 24,000 cfm each with two row steam coils. These units were furnished completely insulated and laid out so that direct-expansion coils may be installed at some time in the future, permitting periodic air conditioning of individual areas as the need arises.

In the receiving area there are blow-down unit heaters installed at each of the fourteen large doors leading in from the outside. The heaters are an excellent means of supplemental heat during the cold months when, because the doors constantly are being opened and closed, a good deal of cold air moves into this part of the building.

Northwest Regional Section ASRE To Meet at Portland

AMONG the first of regional meetings being sponsored by the American Society of Refrigerating Engineers, will be the Region 9 program on March 14 and 15. Featured speakers are Dr. Donald K. Tressler, consultant and recently technical director of the U. S. Quartermaster Food and Container Institute; also Herman F. Spoehrer, vice-president of Sporlan Valve Company, and president, ASRE; and Frank J. Hibbs, Jr., chief engineer, Associated Refrigerating Engineers, Los Angeles.

The regional meeting, a new development in ASRE activities, will open with a Sections Workshop, followed by a welcome luncheon and an address by Dr. Tressler. His topic will be Recent Developments in Food Preservation. A cocktail hour and banquet will be followed by Spoehrer's address on The Engineer's Responsibility to Industry.

Hibbs' presentation on Vacuum Cooling will open the Saturday sessions. Following luncheon a field trip is scheduled to Bonneville Dam. According to Lynn I. Mills, Chairman of the Oregon Section, ASRE, the host Section will conclude the two-day meet with a dinner dance at the Riverside Club. Mills is a past National Director NAPRE and chief engineer of Northwestern Ice & Cold Storage Company, Portland. The meeting will be held at the Washington Hotel, Portland. Region IX of the Society embraces six sections including Western Canada.

ASRE–ASHAE Merger

MEMBERS of the American Society of Refrigerating Engineers and the American Society of Heating and Air Conditioning Engineers learned through a joint statement issued on January 31, that councils of the two societies had approved further study of a method for merging the two groups. A joint committee on cooperation had reported to their respective councils at a special meeting in Pittsburgh on January 24. Council of the two societies will present that report to their memberships more formally through regional and sectional meetings during Spring, 1958.

Both societies, providing a subsequent committee report is approved by their councils in June (presumably at their joint meeting in the Twin Cities) will present a method of merger to members attending 1958 Summer meetings. The release stated that both councils will request approval to submit the proposition for a membership vote at the winter meetings of the two societies.

Nuclear Congress and Fair

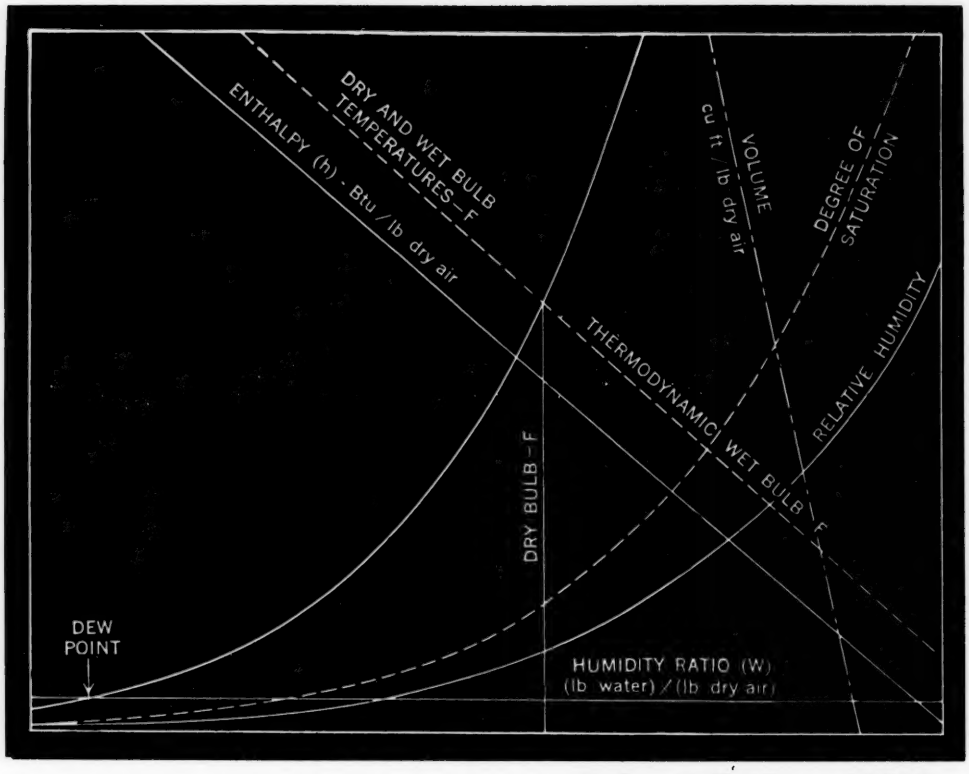
FOURTH Nuclear Congress to be held in the United States occurs March 7-21 at Chicago's International Amphitheatre. Sponsored by more than 30 organizations, the Nuclear Congress, an atomic industrial forum, will present a program of more than 150 scientific and technical papers, plus exhibits which are being featured as an AtomFair.

Conference subjects at the five-day Nuclear Congress include discussions on nuclear education and training, commercial uses of radioactive tracers, food irradiation, progress in commercial power reactor developments, etc. Among the most impressive exhibits at the AtomFair will be the nuclear reactors. These will be shown in various sizes and designs. At least two reactors will be actual operating units. One is the portable package nuclear power plant developed for the Army, the other is a student training reactor.

Canadian Frozen Food Plant for Retail Outlets

CANADA'S largest retail-owned frozen food plant has been opened by Dominion Stores Ltd. at its Toronto headquarters. Designed to serve more than 130 retail outlets in Ontario, the 520,000 cu. ft. freezer storage is valued at $750,000, including inventory.

The plant has a total floor space of 16,000 square feet. Its cold room will be kept at a constant minus 10 F.


DRY AND WET BULB TEMPERATURES - F
ENTHALPY (h) - Btu / lb dry air
VOLUME cu ft / lb dry air
DEGREE OF SATURATION
RELATIVE HUMIDITY
THERMODYNAMIC WET BULB - F
DRY BULB - F
DEW POINT
HUMIDITY RATIO (W) (lb water) / (lb dry air)

—Psychrometric Chart Courtesy A.S.H.A.E.

HUMIDITY and its Control

BY NORMAN SHARPE

an NAPRE Educational Paper

HUMIDITY is a broad general term referring to the moisture concentration in the air. In order to give the term definite meaning, qualifying adjectives are used resulting in the restricted terms: absolute humidity, relative humidity, specific humidity and humidity ratio. The terms *absolute humidity* and *relative humidity* have special significance when dealing with the evaporation of moisture from comestibles* such as produce. *Specific humidity* or *humidity ratio* has similar significance when dealing with the *removal of moisture at the cooling coils.*

Thus, the problem of humidity control can be divided into two parts: (1) moisture given up by edibles within a refrigerated space, and (2) moisture removed by the refrigerated surface (evaporator). A mechanical picture of heat and moisture transfer will provide a better understanding of what must be done to control humidity in space either above or below 32 F.

Part I Moisture Evaporation

To clarify the concept of humidity, resurrect the old term *absolute* humidity—a term so old that it seldom appears anywhere but in physics textbooks.

Absolute Humidity

Absolute humidity is defined as the weight of water vapor per unit volume of air; may be stated in grains of moisture per cubic foot of air, or in the fractional part of a pound of moisture per cubic foot of air. This term is considered absolute because it is dependent only on the dew-point temperature of the air. It is independent of altitude, barometric pressure, air density or any other factor. Now why is this term so independent?

According to Dalton's principle, in a mixture of gases each gas acts independently of the other. This principle also holds for mixtures of gases and vapors if the density of the vapor is low. The density of the water vapor in the air is very low. At 32 F the density of saturated water vapor is only 0.000303 lb per cu. ft. The presence of the dry gases of the air has so little effect on the behavior of the water vapor that this effect defies measurement.

Therefore, when the air is saturated with water vapor the absolute humidity is the same as the density

*Edibles; suitable to be eaten; esculents.

of saturated steam at its saturation temperature, and can be read directly from steam tables. Since air becomes saturated with moisture at its dew-point temperature we can find the absolute humidity by reading from the density column of a saturated steam table at the dew-point temperature of the air.

Moisture Doubles, Each 20F

The maximum absolute humidity of air varies widely with its temperature. Table 1 and Fig. 1 show the absolute humidity of saturated air at temperatures from minus 40 to 40 F. At 40 F, saturated air can hold 55 times as much moisture as it can hold at minus 40 F. The moisture holding capacity more than doubles with each 20 F rise in temperature.

Comestibles are cooled not only to prevent spoilage but also to prevent shrinkage from dehydration. The importance of the maintenance of low temperature cannot be too strongly stressed. Studies of the U. S. Department of Agriculture[1] showed that peas, even when packed and sealed in paperboard packages, when stored at 15 F lost about twice as much weight as those stored at 0 F under conditions of relative humidity similar to those in most storage plants.

About The Author—

Norman Sharpe gained his practical commercial refrigeration and air conditioning experience as an engineer for Carrier Corporation at Newark, New Jersey and Los Angeles, California. Post WWII he served the industrial refrigeration field as an engineer for Luppen and Hawley, Inc., a Sacramento, Calif., contracting firm. He is now Head, Refrigeration and Air Conditioning Department, California State Polytechnic College at San Luis Obispo, California. Humidity and Its Control was prepared by Professor Harold P. Hayes, Dean of Engineering, California State Poly. College, and Chairman, NAPRE Educational Committee, and Sharpe.

Sharpe is author of Refrigeration Principles and Practices, McGraw-Hill Book Company, New York, N. Y. 1950; Heat and Vapor Transfer of Cooling Coils at High Elevation, *Refrigerating Engineering,* **October 1952; The Economies of Air Purification,** *Refrigerating Engineering,* **September, 1953; and Co-Author with Mr. Carl Moore: Variable Elevation Psychrometric Chart, 1950. He delivered "Humidity and Its Control" at the 48th Annual NAPRE Meeting, Chicago.**

Table 1. Maximum Moisture Holding Capacity of Air

Temp F	lbs/cu. ft.	gr/cu. ft.
−40	0.00000743	0.052
−30	0.0000134	0.094
−20	0.0000236	0.16
−10	0.0000404	0.28
0	0.0000674	0.47
+10	0.000110	0.77
+20	0.000177	1.24
+30	0.000278	1.95
+32	0.000303	2.12
+40	0.000409	2.86

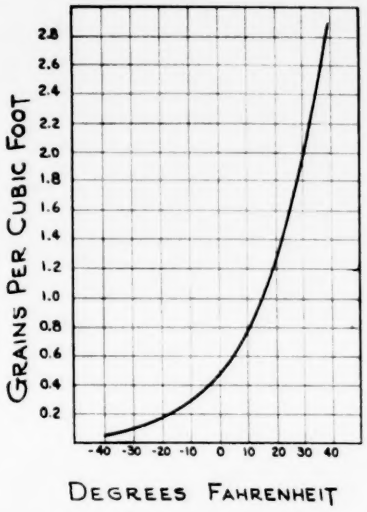


Fig. 1—Moisture Capacity of Air

Relative Humidity

Relative humidity is the ratio of the absolute humidity of the air to the absolute humidity in the air if it were saturated at the dry-bulb temperature. An equally good definition is: relative humidity is the ratio of the vapor pressure in the air to the vapor pressure in the air if it were saturated at the dry-bulb temperature. When coupled with air temperature, the first definition gives a clear picture of the amount of moisture in the air and also the additional amount that it can hold before it becomes saturated. Thus at 0 F, saturated air has a maximum moisture holding capacity of 0.47 grain cu. ft. At 0 F and 80 percent relative humidity the amount of moisture in the air is:

$$0.47 \times 0.80 = 0.38 \text{ gr/cu. ft.}$$

The amount of moisture which can be added to the air before it becomes saturated is:

$$0.47 - 0.38 = 0.09 \text{ gr/cu.ft.}$$

If saturated air at any temperature were passed over a food product there would be no moisture evaporated from it, since the air would have all of the moisture it could hold. Now, if air in an unsaturated condition were continuously passed over the same eatable evaporation would occur until saturation of the air was reached.

The driving potential causing evaporation at a designated air velocity is the amount of moisture which this air can take in before it becomes saturated. Simple calculations can show that the driving potential is a function of both temperature and relative humidity. Thus the potential causing evaporation for air at 32 F with 80 percent relative humidity, is about the same as for air at 0 F with ten percent relative humidity.

Air Velocity Effect on Produce Moisture Evaporation

Most fruits and vegetables are composed of more than 90 percent water. If it were not for their protective skins, they would dehydrate rapidly. Some fruits and vegetables like apples and potatoes have nearly waterproof skins, while the skins of leafy vegetables such as lettuce and spinach give them relatively little protection. It is fortunate that nature did not make any of these skins vapor proof since all unfrozen produce must breathe. Fruits and vegetables are alive and carry on many of the processes characteristic of living things.[2] Both before and after harvest fruits and vegetables take in oxygen and give off carbon dioxide and water vapor. Produce is kept alive by burning a portion of its stored food. The life process must continue or the produce would soon spoil.

Lowering the temperature of fruits or vegetables lowers their rate of evaporation but does not stop it unless the product becomes frozen.

Freezing of vegetables destroys their life but does not stop the action of enzymes within them. Hence freezing should be avoided unless these are first blanched and afterward held at very low temperature until used.

Unfrozen fruits and vegetables give off moisture both by respiration and evaporation, forming a humidified layer of air next to their skin. The removal of this moisture is both by diffusion and mechanical mixing of the air stream with this humidified layer. In still air the process is one primarily of diffusion, while with increased air velocity the process is one primarily of mechanical mixing of the humidified layer with the air stream. Vegetables with thin skins such as lettuce or spinach are very subject to increased rates of dehydration with stepped up air velocity.

Glazing and Packaging For Retarding Evaporation

To prevent dehydration and spoilage of vegetables which are to be kept for several months there is no substitute for freezing, packaging and storing at a low temperature. Preparatory blanching (usually with steam) kills the enzymes and wets the surface of the vegetables. During the freezing process the wet surface becomes a coating of ice. While the coating of ice prevents dehydration, so long as it is maintained, it would soon disappear by sublimation if it were not kept in a nearly saturated atmosphere. The wrapping or packaging with materials nearly impervious to moisture provides a unit enclosure within which the air soon becomes nearly saturated with water vapor. When properly wrapped and held at 0°F or lower there is little difficulty of losing the ice coating.

Methods of preparation and packaging of fish, meats and fruits are too varied to be a part of this paper. However, in each case the same basic methods of prevention of the evaporation of moisture apply. Storage over long periods requires a coating of ice, packaging, and storage at low temperature to prevent excessive dehydration.

Part II Coil Performance

Transfer of heat and moisture to cooling coils presents a more definite pattern than the transfer of heat and moisture from comestibles, since with cooling coils only two conditions of the surface are encountered. Heat and vapor transfer surface is either coated with water or with ice, depending on whether this surface is maintained above or below 32 F.

Based on test data which was used to establish the psychrometric chart, it can be shown by mathematical treatment, that heat and vapor transfer are analogous phenomena and may be treated in like manner. It can also be shown that for any designated coil a line may be drawn on the psychrometric chart which will represent the performance of the coil. In order to deal with this simultaneous transfer of heat and water vapor it will be necessary to introduce a few new terms.

Specific Humidity or Humidity Ratio

Specific humidity and *humidity ratio* are synonymous terms and can be used interchangeably. *Specific humidity* is the weight of water vapor associated with one pound of dry air in a mixture of dry air and water vapor. *Dry air* is defined as the atmospheric gases exclusive of the water vapor. At first glance this would seem to be somewhat of an awkward term since one pound of dry air with its associated moisture weighs slightly more than one pound. However, when one considers simultaneous heat and vapor transfer, *specific humidity* becomes quite a useful term.

About 150 years ago John Dalton showed that in a mixture of gases, each gas acted independently of the presence of the other gases. This principle can be applied to simultaneous heat and water vapor transfer in cooling coils. By using the concept of *specific humidity*, and relating all properties of moist air to the pounds of dry air in the mixture of dry air and water vapor, water vapor and the dry gases are handled separately.

Surface Film Transfer

Here is what happens at the chilled surface of a cooling coil. Most cooling coils are designed with closely spaced fins so that a large portion of the air will contact the cooling surface. The refrigerant tubes passing through these fins usually have a staggered arrangement to promote air turbulence so that a still larger portion of the air will contact the cooling surface. At all times there is a thin absorbed air film on the cooling surface. Heat and vapor transfer takes place by the mixing of the molecules of this surface film with the molecules of the air stream.

Due to the mixing process molecules are continuously entering and leaving this surface film. The molecules which momentarily become a part of this surface film arrive at substantially the same temperature as the cooling surface and are said to have contacted the surface. J. H. Arnold, in his study of the psychrometer,[3] showed that at very low velocity an appreciable portion of heat transfer was by diffusion, but at higher velocities heat transfer by diffusion was a negligible part of the total heat transfer. When the air velocity is 200 f.p.m. or more, practically all of the heat and vapor transfer is by the mixing of the air stream with the molecules of adsorbed air film. An equal number of molecules of the dry air enter and leave the film without changing phase.

The number of molecules of moisture entering and leaving the film without changing phase are also equal if the surface temperature is above the dew-point temperature of the air stream. If the surface temperature is below the dew-point temperature of the air stream but above 32F, the adsorbed air film becomes saturated and excess moisture condenses out in the form of liquid water. If the surface temperature is below the temperature of the air stream and also below 32 F, the condensate forms an ice film on the coil surface. In either of the last two cases the weight of moist air entering and leaving the coil, varied but the weight of the dry air remained constant. Further analyses would show that the only item which can be depended upon to remain constant in either a psychrometric process or a simultaneous heat and vapor transfer process, is the pounds of dry air. Hence, all simultaneous heat and vapor transfer processes use pounds of dry air as the reference basis even though this dry air may be saturated with water vapor.

Specific Enthalpy of Moist Air

Users of refrigeration are not concerned with the absolute heat content of air but the heat content above a suitable datum. The specific enthalpy of moist air is the heat content above 0 F for the dry gases added to the heat content above 32 F for the water vapor. This term (specific enthalpy of moisture) is used in nearly all combined calculations.

Heat and Water Vapor Transfer are Analogous Phenomena and Both are Mass Transport Phenomena in All Respects. The author believes that the investigations establishing the thermodynamic wet-bulb line contains the most accurate measurements ever made in the field of air-conditioning.[3, 4, 5] Since these experiments involve the simultaneous transfer of heat and water vapor it affords the best available data for studying the relationship between heat and water vapor transfer.

The thermodynamic wet-bulb line is defined as *the line of adiabatic humidification;* in other words, it is *the line at which humidification would occur if there were no heat transfer to the process from an outside source.* With air velocities between 200 and 4000 fpm the ordinary psychrometers (sling or aspiration types) measure the thermodynamic wet-bulb with a remarkable degree of accuracy.[4]

It has been found that a certain thermodynamic term called the sigma function (Σ) remains constant along this line. The sigma function is the *specific gravity* of the air minus the heat required to raise the liquid water in the air from 32°F to the wet-bulb temperature. Numerically, the sigma function nearly equals the *specific enthalpy.* The difference in the air conditioning and refrigeration range is usually less than two percent of the enthalpy value.

Defining Σ mathematically we have:

$$\Sigma = h - wh_f \quad (1)$$

where h = the specific enthalpy of moist air, Btu/lb. dry air
w = the specific humidity of the moist air, lb water/lb dry air
h_f = The specific enthalpy of the liquid water (heat required to raise the liquid water in the air from 32 F to the wet-bulb temperature) Btu/lb dry air.

When water is vaporized into the air adiabatically, the necessary head of vaporization must be supplied by the air and hence the air temperature drops. The heat received by the water is returned to the air in the form of latent heat. The increase of latent heat of the mixture is compensated by an equal decrease of sensible heat.

Consider the saturation of one pound of dry air at temperature (t) and specific humidity (w) with an adiabatic saturation temperature t'. The sigma function for the unsaturated mixture is:

$$\Sigma = C_{pa}\,t + wC_{ps}\,(t - t') + wh'_{fg} \quad (2)$$

where C_{pa} = the specific heat of the dry air at constant pressure, Btu/(lb) (°F)
C_{ps} = the specific heat of water vapor at constant pressure
h'_{fg} = the enthalpy of evaporation of water at the temperature of adiabatic saturation, Btu/lb of water

When the air becomes adiabatically saturated the sigma function is:

$$\Sigma = C_{pa}\,t' + w'h'_{fg} \quad (3)$$

Since the sigma function is constant along the line of adiabatic humidification equations (2) and (3) may be combined:

$$C_{pa}\,(t - t') + wC_{ps}\,(t - t') = h_{fg}\,(w' - w) \quad (4)$$

Sensible Losses Equal Latent Heat Gains

This equation states that the combined decrease in the sensible heat of the dry air and the water vapor is equal to the increase of latent heat in the air. Since the thermodynamic wet-bulb line defines a sensible and latent heat transfer exchange, this line may also be described with sensible heat and water vapor transfer coefficients.

Define first the sensible heat and water vapor transfer coefficients:

Surface coefficient of sensible heat transfer is defined as the heat transferred per hour, per unit surface area, per unit temperature difference, causing the heat to flow.

$$Q = fA\,(ts - ta) \quad (5)$$

where Q = sensible heat transferred, Btu/hr
f = surface coefficient of sensible heat transfer, Btu/(hr) (sq ft) (°F)
t_s = temperature of the absorbed air film, °F
t_a = temperature of the air stream, °F

Likewise, the surface coefficient of water vapor transfer will be defined as the weight of water vapor transferred per unit of surface area per hr, per unit specific humidity difference causing the water vapor to flow.

$$M = f_v A\,(w_s - w_a) \quad (6)$$

where M = mass of water vapor transferred, lb/hr
f_v = the surface coefficient of vapor transfer, lb/(hr) (sq ft) (Δw)
w_s = specific humidity of the absorbed air film, lb water/lb dry air
w_a = specific humidty of the air stream.

Thermodvnamic wet-bulb line is thereby defined in terms of heat and vapor transfer coefficients;

$$f\,(t - t') = f_v\,(w' - w)\,h_{fg} \quad (7)$$

As with equation (4), equation (7) states that the *sensible heat lost equals the latent heat gained.*

Transposing equation (7) we have:

$$\frac{f}{f_v} = \frac{h_{fg}\,(w' - w)}{(t - t')} \quad (8)$$

But from equation (4) we have:

$$t - t' = \frac{h_{fg}\,(w' - w)}{C_{pa} + wC_{ps}} \quad (9)$$

Combining equations (8) and (9) we have:

$$\frac{f}{f_v} = C_{pa} + wC_{ps} = Cm \quad (10)$$

Heat-Humidity Ratios Alike

The right hand side of the equation (Cpa + wCps) is the sensible heat required to raise one pound of dry air with its associated moisture through one degree Fahrenheit and is called the moist specific heat of air. The specific heat of the dry air is 0.240 throughout the refrigeration and air conditioning range. The term wCps varies with the specific humidity of the air but has a very small magnitude. At 0 F dew-point its value is only 0.00004 Btu while at 50° dew-point its value is only 0.0034 Btu. Thus we see that the ratio of the coefficient of sensible heat transfer varies slightly with the specific humidity of the air, but for any designated specific humidity condition the ratio is accurately a *constant,* indicating sensible heat and water vapor transfer are analogous.

Retrace and examine the accuracy of this deduction which actually is based on experimental data establishing the thermodynamic wet-bulb line. Many investigators found that with well calibrated psychrometers used at air velocities between 200 and 4000 fpm the thermodynamic wet-bulb temperature could be determined within an accuracy of 0.1 F. *To the accuracy with which the psychrometer can be used to measure the thermodynamic wet-bulb temperature the transfer of water vapor is an analogous phenomena to the transfer of sensible heat.*

A mechanical picture by which this heat and vapor transfer occurs is easily obtained. The examination of equation (5) defining the sensible heat transfer coefficient gives no clue of the process. However, in equation (6) the mechanical process becomes apparent. The vapor transfer coefficient (fv) is the pounds of water transferred per hour, per square foot of wetted surface, per pound difference in specific humidity. Also the driving potential is the difference in specific humidity between the adsorbed air film and the air stream. The coefficient (fv) is therefore a coefficient of mass transfer of water vapor.

Since thermal conductivity within a gas is a result of diffusion mass transfer can occur between the air

stream and the adsorbed film on the cooling surface only by diffusion or by mechanical mixing of the molecules. Since J. H. Arnold, in his study of the psychrometer,[3] showed that the amount of vapor transferred by diffusion was a negligible part of the total, if the air was flowing at normal velocities, the vapor transfer process must be almost entirely one of mechanical mixing of the molecules of the air stream with the molecules of the adsorbed air film. Now since we have shown that the vapor transfer process has been shown as analogous to the sensible heat transfer process, the sensible heat transfer process must also be almost entirely one of mechanical mixing of the molecules of the air stream with those of the adsorbed air film.

Deductions Substantiated

Since these deductions are based on experimentation of irrefutable accuracy used in establishing the thermodynamic wet-bulb line, of the psychrometric chart we are faced with the conclusion faced is that simultaneous heat and water vapor transfer is almost entirely due to mechanical mixing of the molecules of the air stream with those of the adsorbed air film at the cooling surface.

Contact Efficiency and Cooling Coils Performance

Only the mechanical action of heat and vapor transfer between the air stream and the adsorbed air film has been discussed thus far. Now what is the relation between the temperature of the adsorbed film and the metal surface of the cooling coil? With coils condensing moisture above 32 F or with lightly frosted coils there is usually less than one degree temperature difference between the adsorbed film and the metal surface. However, with heavily frosted coils there may be several degrees temperature difference.

Varies 'tween Refrigerants

Heat transfer from the refrigerant through the tubes, fins, and coating of water or ice to the adsorbed air film is not a part of this paper since this phase of the problem has no direct relation with humidity and its control. However, the temperature difference between the refrigerant and the adsorbed air film is usually slightly less than the temperature difference between the adsorbed air film and the entering air stream when ammonia is used as the refrigerant, and slightly greater than the temperature difference between the air film and the entering air stream when one of the halogenated refrigerants is used.

By-Pass Factor Explained

At the coil surface, molecules which momentarily become a part of the adsorbed air film arrive substantially at the temperature of the wetted or iced surface and are said to have contacted this surface. The molecules which do not contact the surface are said to have by-passed the surface. Contacted air is that portion of the air which has been a part of the adsorbed air film and is at the same temperature as the adsorbed air film. By-passed air is that portion of the air which passes through the coil without contacting of the surface and is at the same temperature as the entering air stream.

Air leaving the coil is a mixture of the contacted air and the by-passed air. The percentage of the total air stream which comprises the contacted air is termed the *contact efficiency* and the percentage of the total air which comprises the by-passed air is termed the *by-pass factor*.[6] Refrigeration coils have contact efficiencies up to about 80 percent. Contact efficiency for a designated coil is a function only of the mass rate of air flow through it.[7] Therefore, for a given rate of air flow the contact efficiency fully describes the simultaneous transfer of heat and water vapor to the coil surface.

Consider the simultaneous removal of sensible heat and water vapor by a coil having 80 percent contact efficiency with air entering at 35FDB and 31FDP with a surface temperature of 27F. Heat and vapor transfer process is one of mixing. Since it is known that the mixing process can be represented by a straight line on the psychrometric chart (with negligible error) and since the coil surface will be condensing moisture, the adsorbed air film will be in a saturated condition and can be represented by a point on the saturation curve at 27F.

Plotting Performance on Psychrometric Chart

Performance of the coil will then be represented by a straight line drawn between 35°DB, 31°DP and 27° at the saturation curve (Fig. 2). Air leaving evaporator coil will be

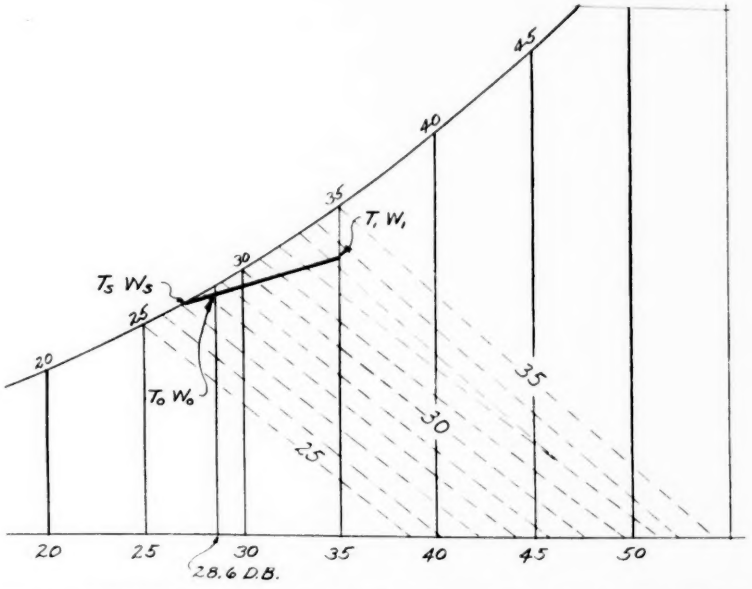


Fig. 2—Combined heat and vapor transfer process as it would appear on a psychrometric chart:

$t_i w_i$ = *Temperature and specific humidity of the air entering the coil; 35° DB, 0.0036 lb moisture per lb of dry air*

$t_o w_o$ = *temperature and specific humidity of the air leaving the coil; 28.6F DB, 0.00312 lb of moisture per lb of dry air*

$t_s w_s$ = *temperature and specific humidity of the absorbed air film at the coil surface; 27° DB, 0.0030 lb of moisture per lb of dry air.*

EXCLUSIVELY

cooled 80 percent of the way toward the 27F surface temperature along this line. The condition leaving the coil will then be 28.6°DB and 27.8 DP. The sensible heat removed per pound of dry air passing through it will be the temperature change times the moist specific heat of the air.

$$(35 - 28.6) \times 0.241 =$$
1.54 Btu/lb, dry air

Ice deposited on the coil will be the difference of specific humidities between 31°DP and 27.8 DP:

$$0.0036 - 0.00312 =$$
0.00048 lb, moisture/lb, dry air.

It would appear that the amount of moisture removed were very small. However, consider that the latent heat of sublimation of ice at 27.8F DP is 1219 Btu/lb. Refrigeration required to remove the moisture is an appreciable portion of the total. In this case, the refrigeration required to reduce the moisture per pound of dry air passing through coil would be:

$$1219 \times 0.00048 = 0.58 \text{ Btu/lb.}$$

Total refrigeration would be:

$$1.54 + 0.58 = 2.12 \text{ Btu/lb, dry air.}$$

And, the percentage of the total refrigeration required to remove the moisture would be:

$$0.58 \div 2.12 = 27 \text{ percent.}$$

Moisture Equilibrium Between Product Evaporation And Coil Condensation

Since this proof of the analogy between sensible heat and water vapor transfer show that Dalton's principle applies to simultaneous heat and vapor transfer, two separate diagrams will show the performance of the coil with regard to these two types of transfer. Fig. 3a shows the sensible heat transfer of the coil, per pound of dry air with its associated moisture. Fig. 3b shows the corresponding moisture transfer.

Sensible heat transferred =

$$(t_i - t_o)\, C_m$$

where C_m =
the moist specific heat of the air.
Sensible heat transferred =
$(35 - 28.6) \times 0.241 = 1.54$ Btu/lb dry air with its associated moisture.

Ice removed by the coil
= 0.0036 − 0.00312
= 0.00048 lb. moisture/lb, dry air.

Latent heat transfer
= 0.00048 x 1219
= 0.58 Btu/lb, dry air with its associated moisture passing through the coil.

Difference of absolute humidity between the absorbed air film on comestibles and the room air is a driving potential causing the evaporation of moisture. Difference in specific humidity between the air stream through the coil and the adsorbed air film on the coil surface is a driving potential causing the condensation of moisture. Obviously, the quantity of moisture condensed must equal the quantity of moisture evaporated. An increase in the moisture condensed on the coil will be accompanied by a lowering of the relative humidity, with an increased rate of evaporation from the food stuffs. At first glance it would seem desirable that relative humidity should be kept as high as possible and this is substantially true where comestibles are stored in a frozen condition. However, unfrozen fresh fruits and vegetables are alive and breathe hence the moisture from respiration must be removed.

Impractical To Design For All-Temperature Stores

In a cold storage warehouse it is usually impractical to design separate rooms for each type of produce. The type of produce in a particular room will vary from season to season or year to year. Sometimes many types of produce are stored in a single room. When this is done, care must be taken that the optimum storage condition is nearly the same for the various types of produce concerned. Most unfrozen produce has an optimum storage temperature between 30 and 32 F. The optimum humidity is usually between 80 and 90 percent, depending on the moisture content of the product.

If the room is loaded with a single product and has sufficient coil to maintain the room temperature at 32 F with a surface temperature of 26 F, the humidity will tend to approach the optimum for that product.[8] Certain produce, notably lettuce and other leafy vegetables require humidities of 90 to 95 percent. These humidities may be maintained by occasionally sprinkling the floors or top icing of the crates. With certain other produce, notably lemons, avacados and bananas the optimum storage temperature is considerably above 32F. The higher temperature can be maintained in a room designed for general storage without lowering of the relative humidity if the coil is equipped with a suction control valve in addition to whatever temperature control device it may have.

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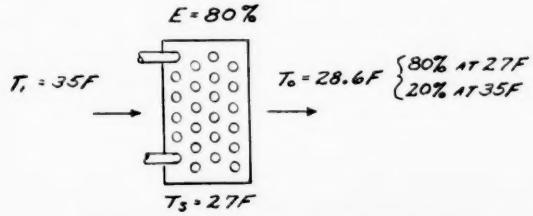

Fig. 3(a)—Illustration of sensible Heat Transfer

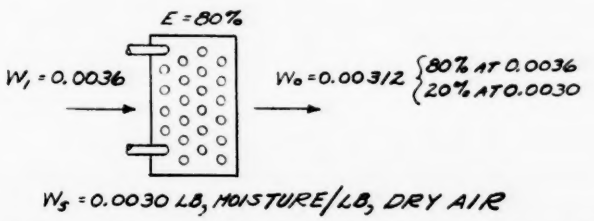

Fig. 3(b)—Illustration of Moisture Transfer (lb, mosture/lb, dry air)

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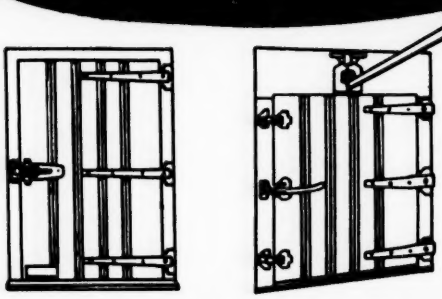

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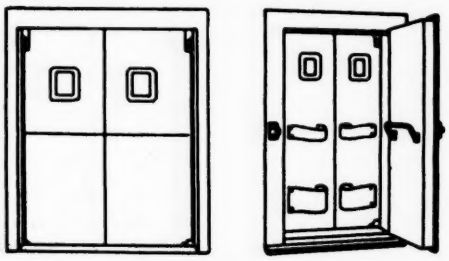

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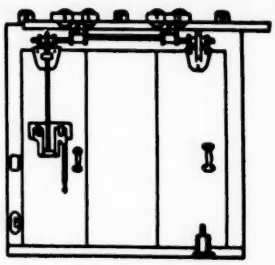

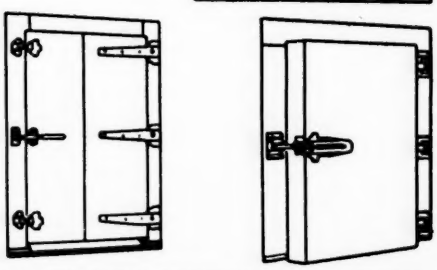

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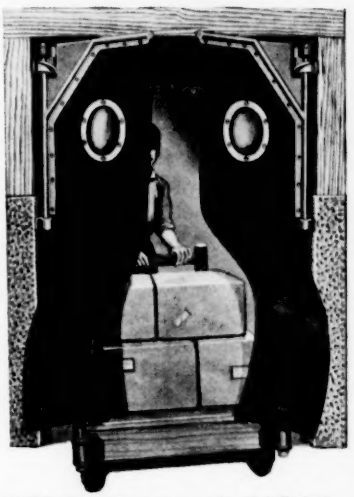

Model TSH battens are made of ¼" thick Neoprene (no grain) or of ¼" tough specially compounded rubber, reinforced with 2 layers of heavy cotton duck. Materials remain flexible even at extremely low temperatures.

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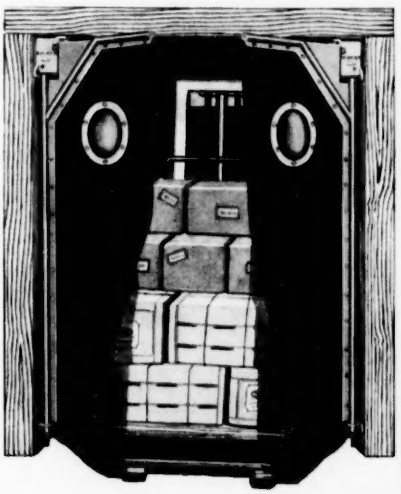

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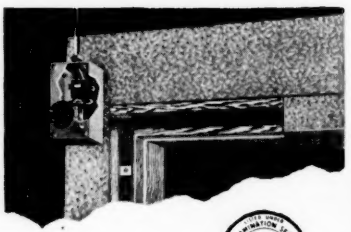

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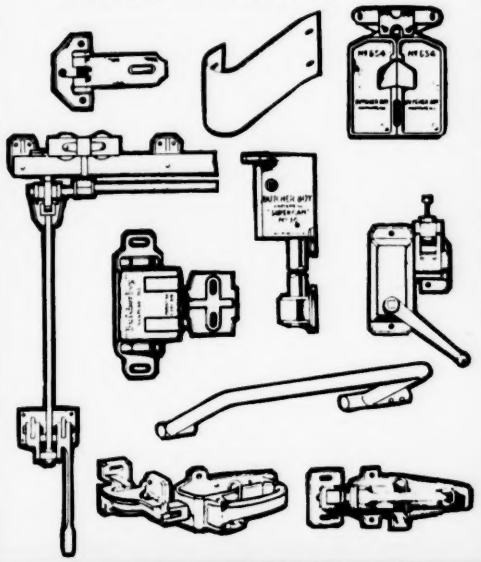

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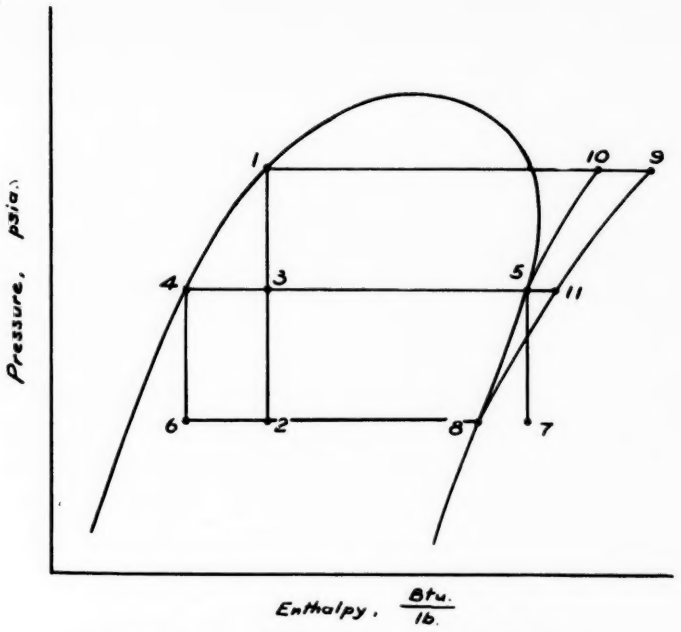


Fig. 8. Interrupting the expansion for removal of flash gas.

Multi-stage Refrigeration

Construction of the pressure-enthalpy diagram (Mollier Chart) was examined in the February installment of this article. That pressure-enthalpy diagram will be used in this continuation to assist in the explanations of the behavior of multi-stage systems. Reviewing: *Two typical features of the multi-stage system are removal of flash gas and intercooling.* The manner in which these processes improve the efficiency of a refrigeration system will now be studied.

Removal of Flash Gas

Attention will at the moment be focused on the expansion process which occurs in the expansion valve. If the expansion takes place in one step, the process on the pressure-enthalpy diagram is a straight, vertical line as is process 4-1 in Fig. 7. As the expansion continues to lower pressures, the fraction of vapor in the refrigerant increases. This is indicated by the steady progression of the state of the refrigerant away from the liquid line and toward the vapor line. The vapor which forms is called flash gas.

What is the effect of the flash gas?

Flash gas is useless for refrigeration, and further expansion of it only requires that the compressor pump the expanded gas back to the condenser pressure. To illustrate, Fig. 8 shows what happens if instead of expanding liquid at 1 to a low pressure of 2, the expansion is interrupted at point 3. The refrigerant at 3 is in the mixture region containing some flash gas along with the liquid. If the liquid and vapor are separated, point 4 represents the liquid and point 5 the flash gas. The folly of expanding the vapor at 5 to point 7 at the low pressure becomes evident when the pattern of the line of constant temperature (Fig. 5) is recalled. Point 7 is at a temperature hardly any lower than point 5 and can therefore do very little refrigerating.

If the flash gas at point 7 can do no refrigeration, why even expand it to the low pressure? Why not just recompress it back to the condensing pressure?

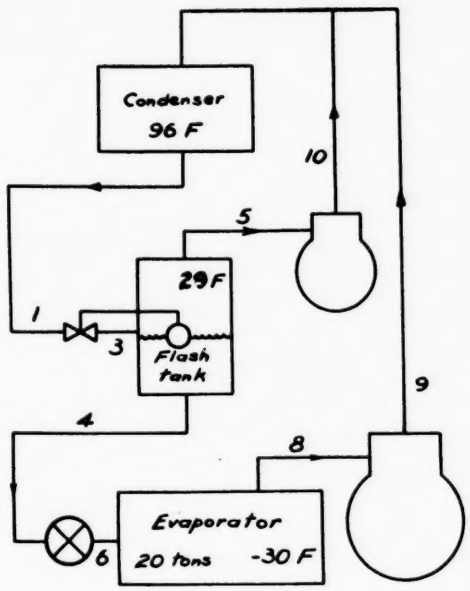
Were the process performed in this new manner, the design will have accomplished flash-gas removal. The equipment needed to perform this operation is shown in Fig. 9 with points corresponding to those on the pressure-enthalpy diagram of Fig. 8.

Liquid from the condenser at 1 expands through the float valve to 3 whereupon it enters the flash tank. The flash tank separates liquid at point 4 from the vapor at point 5. A compressor with a suction pressure the same as the pressure in the flash tank must be available to compress the flash gas.

Improved Efficiency By Flash-Gas Removal

To illustrate with some actual figures, assume that a system is to provide a capacity of 20 tons at an evaporating temperature of − 30 F. The condensing temperature is 96 F and the flash tank operates at 29 F. What is the saving in power by instituting flash-gas removal?

Solving this problem will also illustrate the procedure of a combined



Fi. 9. Refrigeration system employing removal of flash gas.

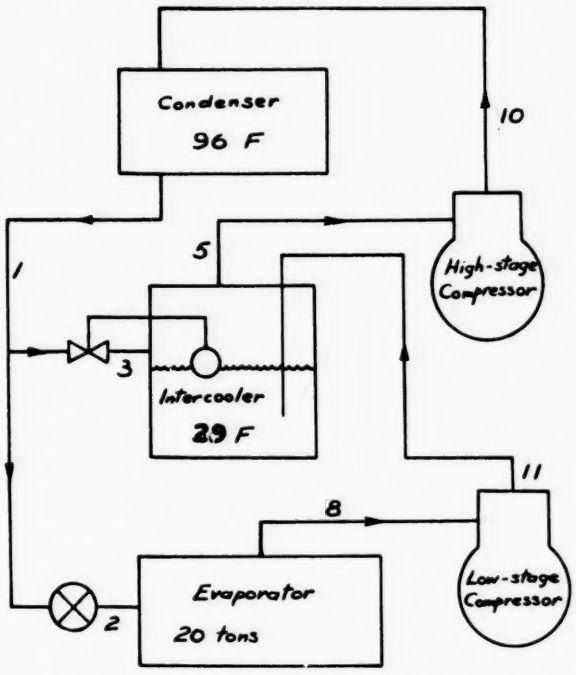


Fig. 10. Refrigeration system employing intercooling.

Systems

heat balance and flow balance about the flash tank. Label additional points on Figs. 8 and 9, points 8, 9, and 10.

Solution: First determine from the pressure-enthalpy diagram the enthalpy at all of the statepoints in Fig. 9. These enthalpies are listed in Table 1. After determining the enthalpies, the rates of flow can then be calculated. Let the symbol w with the appropriate subscript represent the rate of flow at a given point. For example, w_3 is the rate of flow (lbs/min) entering the flash tank.

Applying the principle developed in Fig. 1, and equations (a) and (b),

i) $w_4 = w_6 = w_8 = w_9$

$$= \frac{200 \text{ tons} \times 200 \text{ Btu/min/ton}}{h_8 - h_6}$$

$$= \frac{4000 \text{ Btu/min}}{601 \text{ Btu/lb} - 75 \text{ Btu/lb}}$$

$$= 7.62 \text{ lb/min}$$

To calculate w_5 and w_{10}, the heat and flow balances must be applied about the flash tank. The flow balance states that the quantity of refrigerant entering must equal the amount leaving, or,

j) $w_3 = w_4 + w_5$.

Flow rate w_4 is 7.62 lb/min, so

k) $w_3 = 7.62 + w_5$.

The heat balance says that the heat entering the flash tank in the entering refrigerant must equal the amount of heat leaving the flash tank in the leaving refrigerant. In equation form,

l) $w_3h_3 = w_4h_4 + w_5h_5$

Substituting the values of enthalpy from Table 1 and the values of w_4 and w_3,

m) $(7.62 + w_5)(150 \text{ Btu/lb}) = (7.62)(75) + w_5(620)$

Carrying out the multiplication

n) $1140 + 150\,w_5 = 579 + 620\,w_5$

$$w_5 = \frac{1140 - 579}{620 - 150}$$

$$= \frac{561}{470}$$

$$= 1.195 \text{ lb/min}$$

The power required by each of the compressors can be calculated by applying the principle illustrated in Fig. 3, and equations (f) (g) and (h). The power required by the main compressor is:

o) Power $= w_8(h_9 - h_8)$

$= 7.62(780 - 601)$

$= 1362$ Btu/min

$$= \frac{1362 \text{ Btu/min}}{42.4}$$

$= 32.2$ hp

TABLE 1. ENTHALPIES AT STATEPOINTS IN FIGURE 9.

h_1	= 150 Btu/lb, on the liquid line at 96 F.
h_2	= 150 Btu/lb, same as h_1
h_3	= 150 Btu/lb, same as h_1
h_4	= 75 Btu/lb, on the liquid line at 29 F.
h_5	= 620 Btu/lb, on the vapor line at 29 F.
h_6	= 75 Btu/lb, same as h_4
h_8	= 601 Btu/lb, on the vapor line at −30 F.
h_9	= 780 Btu/lb, following constant-entropy line from point 8 to 200 psia which is the condensing pressure at 96 F.
h_{10}	= 695 Btu/lb, following constant-entropy line from point 5 to 200 psia

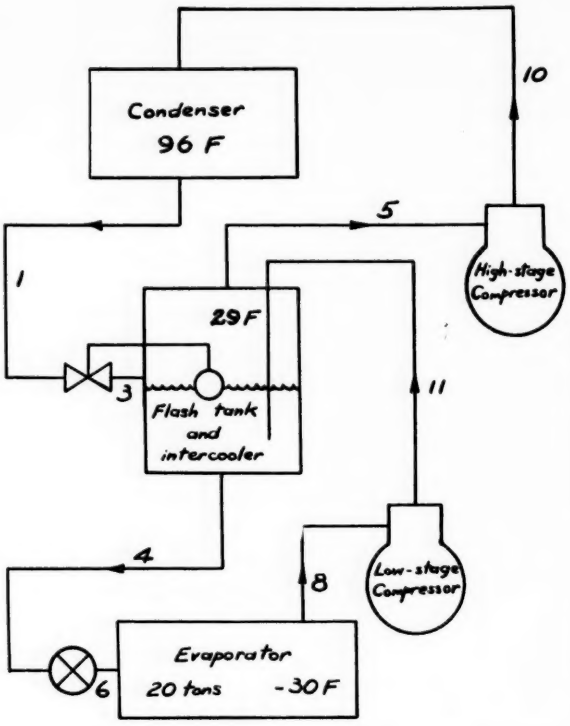


Fig. 11. Combination of intercooling and flash-gas removal.

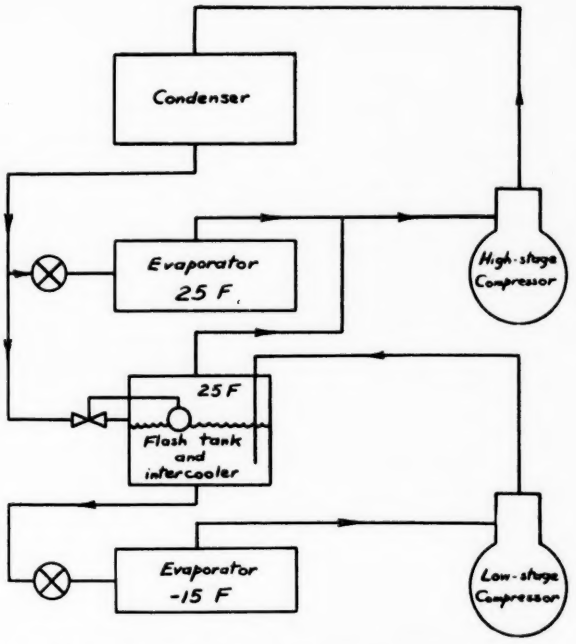


Fig. 12. Multi-stage system for plant where evaporators operate at two temperature levels.

The power required by the flash-gas compressor is:

p) $\text{Power} = w_5(h_{10} - h_5)$
$= 1.195(695 - 620)$
$= 89.7 \text{ Btu/min}$
$= 2.12 \text{ hp}$

The total power is the sum of the power required by the two compressors which is 34.4 hp.

How successful is the removal of flash gas in reducing the power requirement? A single stage system like this one in Fig. 7, but with the 20 ton evaporator at − 30 F, would have a flow rate through the evaporator of

q) $\dfrac{4{,}000 \text{ Btu/min}}{h_8 - h_2} = \dfrac{4{,}000}{601 - 150}$
$= 8.87 \text{ lb/min}$

The power required by the single compressor would be:

r) $\text{Power} = 8.87(h_9 - h_8)$
$= 8.87(780 - 601)$
$= 1585 \text{ Btu/min}$
$= 37.5 \text{ hp.}$

The saving by using flash-gas removal is therefore

s) $\text{Saving} = \dfrac{37.5 - 34.4}{37.5}$
$= \dfrac{3.1}{37.5} = 8.3\%$

Intercooling

The second basic process used in most multistage systems is "intercooling." Intercooling in two-stage compression is the cooling of the discharge gas from the low-stage compressor before the gas enters the suction side of the high-stage compressor. If a system operates with a 20-ton evaporator at − 30 F and a condensing temperature of 96 F as before, what will be the saving in power by intercooling with liquid refrigerant at 29 F? In this case only intercooling will be used; there will be no removal of flash gas.

The equipment for performing the intercooling process is shown in Fig. 10. To perform the intercooling, some liquid must be drawn from the liquid line which feeds the evaporator. The discharge gas from the low-stage compressor at point 11 bubbles through the liquid in the intercooler to cool it to the vapor line at point 5. Points are numbered in Fig. 10 to correspond with statepoints in Fig. 8. Table 1 gives the enthalpy of the points except for h_{11} which from the pressure-enthalpy diagram is 686 Btu/lb.

The rate of flow through the compressors is found in a manner similar to that used in the example involving removal of flash gas, equation (i).

ii) $w_2 = w_8 = w_{11}$
$= \dfrac{20 \text{ tons} \times 200 \text{ Btu/min/ton}}{h_8 - h_2}$
$= \dfrac{4{,}000 \text{ Btu/min}}{601 - 150}$
$= 8.85 \text{ lb/min.}$

The rate of flow through the high-stage compressor can be calculated from a flow balance and heat balance about the intercooler. The flow balance is:

jj) $w_3 + w_{11} = w_5$
or, $w_3 = w_5 - 8.85$

and the heat balance is,

ll) $w_3h_3 + w_{11}h_{11} = w_5h_5$

Substituting the known values,

nn) $(w_5 - 8.85)150 + 8.85(686)$
$= 620\, w_5$
$150\, w_5 - 1330 + 6060 = 620\, w_5$
$w_5 = \dfrac{6060 - 1330}{620 - 150}$
$= 10.05 \text{ lb/min}$

The high-stage compressor pumps a greater flow than the low-stage because of the addition of liquid at point 3 to cool the discharge gas from the low-stage compressor.

The power required by the two compressors is:

oo) Low-stage power
$= 8.85(h_{11} - h_8)$
$= 8.85(686 - 601)$
$= 770 \text{ Btu/min} = 18.2 \text{ hp}$

pp) High-stage power
$= 10.05(h_{10} - h_5)$
$= 10.05(695 - 620)$
$= 755 \text{ Btu/min} = 17.8 \text{ hp}$
Total power $= 18.2 + 17.8$
$= 36.0 \text{ hp}$

Compared to the system which uses no intercooling or flash gas removal the saving in power is

ss) $\text{Saving} = \dfrac{37.5 - 36.0}{37.5} = 4.0\%$

What causes this saving in power by using intercooling? The reason lies in the difference in compressing the refrigerant from 5 to 10 in Fig. 8 rather than from 11 to 9. A compres-

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sion between any two pressures close to the vapor line requires less work than if the compression is some distance to the right of the vapor line. This saving in work more than offsets the higher rate of flow which the high-stage compressor must handle due to the liquid which enters the intercooler at point 3.

Combined Intercooling and Flash-Gas Removal

If both removal of flash gas and intercooling result in a saving of power, can they be combined? The answer is, yes, as Fig. 11 shows. The functions of the flash tank and intercooler are combined into one vessel.

Calculating the power required by the compressors is done in a manner similar to the previous illustrations. After the enthalpies at the statepoints are determined, the rates of flow are calculated by heat and flow balances. The flow through the low-stage compressor is:

iii) $$w_4 = w_6 = w_8 = w_{11} = \frac{20 \text{ tons} \times 200 \text{ Btu/min/ton}}{h_8 - h_6} = \frac{4{,}000 \text{ Btu/min}}{601 - 75} = 7.62 \text{ lb/min}$$

A flow balance about the flash tank-intercooler gives:

jjj) $$w_3 + w_{11} = w_4 + w_5$$

Since $w_4 = w_{11}$, $w_3 = w_5$

The heat balance is:

lll) $$w_3h_3 + w_{11}h_{11} = w_4h_4 + w_5h_5$$

$$150\,w_5 + (7.62)(686) = (7.62)(75) + 620\,w_5$$

$$w_5 = \frac{(7.62)(686 - 75)}{620 - 150} = 9.89 \text{ lb/min}$$

Next, the power required by the compressors is:

ooo) Low-stage power
$$= 7.62(h_{11} - h_8) = 7.62(686 - 601) = 622 \text{ Btu/min} = 15.7 \text{ hp}$$

ppp) High-stage power
$$= 9.89(h_{10} - h_5) = 9.89(695 - 620) = 741 \text{ Btu/min} = 17.5 \text{ hp}$$

Total power
$$= 15.7 + 17.5 = 33.2 \text{ hp}$$

Compared to the system which uses intercooling or flash-gas removal, the saving in power of the combined system is:

sss) $$\text{Saving} = \frac{37.5 - 33.2}{37.5} = 11.5\%$$

Determining Optimum Intermediate Pressure

At what pressure should the combination flash tank and intercooler be maintained to achieve the greatest saving of power? Taking the absurd situations first, there will be no saving if the intermediate pressure equals the condensing pressure, or if it equals the evaporating pressure. In either of these cases there will be no removal of flash gas or intercooling, and the system will revert to the basic one whose appearance is similar to the one in Fig. 7.

Between these two extremes there must be an intermediate pressure which is optimum. Roughly that situation occurs when the loads are equally divided between the two compressors. The optimum intermediate pressure is approximately the square root of the product of the evaporating and condensing temperatures:

t) $$p_{int} = \sqrt{p_e p_c}$$

For the system to balance out with this optimum intermediate pressure, the compressors must be properly sized. A high-stage compressor which has too much capacity, for example, will draw the intermediate pressure below the optimum.

Use Of Evaporator At Intermediate Pressure

Many refrigeration plants, such as in refrigerated warehouses, dairies, chemical and process industries have two or more levels of temperature requirements. Assume, for example, that a refrigerated warehouse has a − 15 F evaporator serving the storage rooms for frozen foods and a 25 F evaporator for some fresh products.

The multistage system for this application is shown in Fig. 12. Liquid from the condenser feeds the 25 F evaporator and the combination flash tank-and-intercooler. Liquid from the flash tank-and-intercooler supplies the − 15 F evaporator. Vapor from the 25 F evaporator and vapor from the flash tank-and-intercooler combine before entering the suction of the high-stage compressor.

The optimum intermediate pressure for most effective use of the flash tank-and-intercooler probably cannot be achieved, because the intermediate pressure is dictated by the pressure of the 25 F evaporator.

Discharge Temperatures

In addition to the saving in power, two-stage compression with intercooling results in lower discharge temperatures from the high-stage compressor. For example, if the compression in Fig. 8 took place from point 8 to point 9 the discharge temperature would be 325 F. By means of intercooling, this discharge temperature can be reduced to its value at point 10 which is 185 F.

A high discharge temperature may result in a partial breakdown of the oil in the compressor, which would accelerate wear.

Compressor Power Required

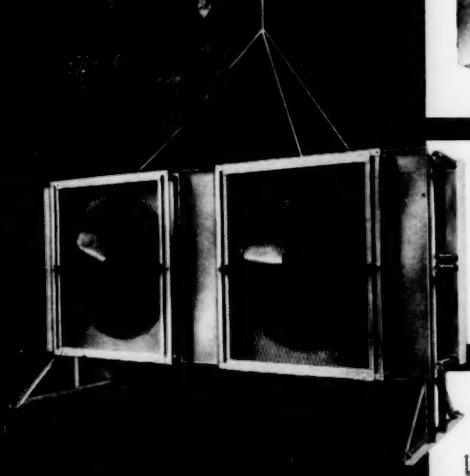
The calculations of the power required by the compressor have up until now been for an *ideal* compressor. The *actual* compressor will require more power than the ideal. Two methods are available to estimate the power that an actual compressor will require. One is to make use of the fact that most compressors operate with compression efficiencies of between 65 and 75 percent. A rough estimate of the actual power requirement can be made, therefore, by dividing the ideal power by the compression efficiency. If the ideal compressor requires 18.0 hp, for example, the actual compressor will require about 18.0 divided by 0.70 which is 25.7 hp.

A more accurate prediction can be made by translating catalog data of compressors. Catalog data of the capacity of a compressor expressed in tons can be converted to the pumping capacity in pounds per minute by performing the reverse procedure illustrated in Fig. 1. These conversions can be made in the range of capacities that is of interest. Next, the required rate of flow can be calculated by the techniques discussed in this paper. Then the speed of the compressor can be calculated by interpolating between flow-rate data of the compressor for two different speeds. When the compressor speed is determined, the power required by the compressor can be found by interpolation between the catalog values of compressor power.

Summary

Multistage refrigeration systems can be analyzed by making heat balances and flow balances about the vessels. Two individual processes, removal of flash gas and intercooling, reduce the power requirement of an ammonia system for a given evaporator load. Both the removal of flash gas and intercooling are possible in a multistage system.

In addition to a saving in power, multistage systems allow the compressors to operate at low pressure ratios which reduces wear on the bearings and other moving parts of the compressor. Intercooling reduces the discharge temperatures of the refrigerant to minimize breakdown of oil which would cause poor lubrication. Removal of flash gas, in addition to saving power, also reduces the volume flow of refrigerant which the low-stage compressor must pump. A smaller low-stage compressor will therefore be adequate.



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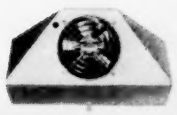

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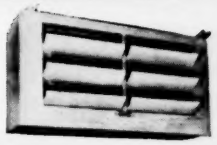

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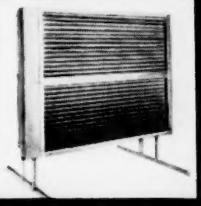

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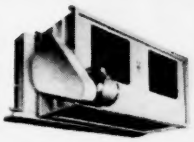

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All refrigerating engineers are invited to affiliate with the National Association of Practical Refrigerating Engineers, Inc., an educational association, "not-for-profit".

From the President's Desk

Some Managements Overlook Indirect Operational Savings

OWNERS and management, what can NAPRE do for your engineering personnel? Some of your friends who are owners or managers of ice and cold storages, freezer plants, dairies, hotels, apartment or office buildings, department stores, are employing members of NAPRE. They will tell you that NAPRE is an educational association not-for-profit, with forty chapters in the United States and several hundred members-at-large in the United States and many countries all over the world.

Personnel affiliated with NAPRE are taught a refrigeration course, BASIC REFRIGERATION by Guy R. King. Members with problems in their plants can bring them to the floor for discussion. And they will get their problems answered. If not answered on the floor, the Chapter always refers it to the Question Box which is published in INDUSTRIAL REFRIGERATION, NAPRE's official organ. This department is handled by Professor Harold P. Hayes, educational chairman, who is Dean of Engineering, California State Polytechnic College, San Luis Obispo.

Owners Welcome at NAPRE Chapter Meetings

Guy King, vice-chairman, is Instructor at Santa Monica City College, California. King directs and advises the chapters with regard to local education and program planning. You, owners and managers, are invited to attend some meetings with your engineers. Verify in person, the claims of NAPRE!

Typical of NAPRE regional efforts to broaden membership practical experience, is the South Central Conference being held in Jackson, Miss., on March 7, 8 and 9. Engineer representatives from six chapters will report back with up-to-date data which will eventually result in savings to management.

NAPRE's aim is to further the education of the practical engineer, to keep him informed on new equipment coming into the field daily, to make a more efficient engineer out of him, and to extend his training from the operating to the technician level. The industrial refrigerating and air conditioning plant of today, and especially that replacement plant you plan for tomorrow, requires the knowledge of a technician as well as the manipulative skill of an operator.

Frank L. Chase

Fall Meeting Announced

Members of NAPRE are officially notified hereby that the 49th annual meeting is to be held Wed., Thurs. & Fri., Nov. 11-13, 1958 at the Kenilworth Hotel, Bal Harbor, Fla. This complies with the preferential ballot of the membership, taken at the 48th meeting, Chicago.

Herr Wins Report Plaudits

Best chapter report in January was by Fred Herr, Los Angeles, although Denver and Colton reports contained some informative material. In that issue Sacramento and Tampa chapters reported very interesting developments on accredited refrigeration instructions for their chapters.

In February, Herr again took the citation for the most informative chapter report. His report on the effect of solar heat gains on operating cost for a central station air conditioning plant is tops. It should be very useful to many NAPRE members responsible for similar plants. New York was runner-up for informative reports; and Kansas City almost neck-and-neck with New York. New York reported on types of flow control valves for evaporators while Kansas City reported on volumetric efficiency of compressors.

Reporting Aim: Usefulness

February was really the type of competition expected among the chapters with regard to reporting. More chapters should send in their reports. Winning recognition and a prize may prove beneficial to a chapter, but providing useful, informative and educational data for the benefit of 39 other chapters and members-at-large, is the loftier objective.

Frank L. Chase

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Photo, right, Depicts Typical Explosive Force

BLAST ROCKS RICHMOND

Attributed To NH_3, May Have Been Due To Gas

HEADLINES in the public press over the third week-end in January bannered the news of an ammonia explosion. They related how a cold storage plant in Richmond, Virginia, had been practically leveled by the force of the explosion. The public press relying on statements from witnesses and some "authorities" at the scene of the disaster attributed the explosion to the refrigerant used. This, in spite of the fact that in the finer print of the reporting there were statements from owner and other officials to the effect that the exact cause had not been determined.

As in the case of a meat plant explosion two years ago in midtown Toledo, Ohio, early reports put the blame on the refrigeration plant, and in particular on the type of refrigerant used. Later the cause of the Toledo blast was determined to be a leaking gas service line. It now appears that the cause of the Richmond blast may be of the same nature.

At least the Richmond firm thinks so, for they initiated proceedings to obtain an injunction which would prevent city authorities from removing a gas main and abandoned service line, adjacent to their building. The firm reached an agreement with the city attorneys, without the injunction. Now, their experts will make an investigation side by side with the city in order to fix the cause.

Details of the investigation, of course, are not available at present. This publication is inclined to rely on the findings of reports of one of our casualty insurance engineering and investigating departments, and in the interest of the industry will report the facts when the cause is determined by competent authority.

"Semper Paratus"*

Management and engineering personnel in industrial refrigeration enterprises are for the most part alert to their responsibilities with respect to the dangerous properties of refrigerants they use, regardless of whether they are ammonia or other types. All respect the potential force inherent in the use of any compressed gas, and take steps to indoctrinate and train their personnel.

As a service to the industry, and in view of the public good will which can be fostered, (and with due credit to the Coast Guard* for using their motto), INDUSTRIAL REFRIGERATION's staff recommends that all refrigerating plants review their safety practices. Thoroughly inspect all systems and even set up an emergency procedure for shutting down, regulating or otherwise confining any derangement that should take place. It is further suggested that business enterprises using refrigeration in fairly large tonnages actually instruct their people on the proper handling of refrigerants, as well as the efficient manipulation of the refrigerating systems.

Association Data Available

Some industry groups have long fostered such programs. As an example, the National Association of Refrigerated Warehouses' Safety Committee in November issued a 2-page leaflet on the handling of refrigerant cylinders. The Manufacturing Chemists Association was cited by this Safety Committee's leaflet as having warning signs which can be obtained, framed and posted in plants, concerning the handling of anhydrous ammonia.

Engineering groups like National Association Practical Refrigerating Engineers, in their chapter meetings have shown and continue to encourage their chapter educational committee to obtain and show films on the handling of compressed gases. These films can be obtained from the Compressed Gas Association at 11-42nd St., New York 36, N. Y.

Offer Reprint of NH_3 Paper

In February, 1955, *Industrial Refrigeration* published a 2-page article by Ken Holaday, Utilities Distribution Engineer, Anheuser-Busch, Inc., entitled, "How Dangerous is Ammonia?" Holaday had given this paper before a number of the NAPRE Chapters. *Industrial Refrigeration* will reprint the paper at an early date if sufficient interest is shown from the readership as the current supply of reprints on this topic has been exhausted.

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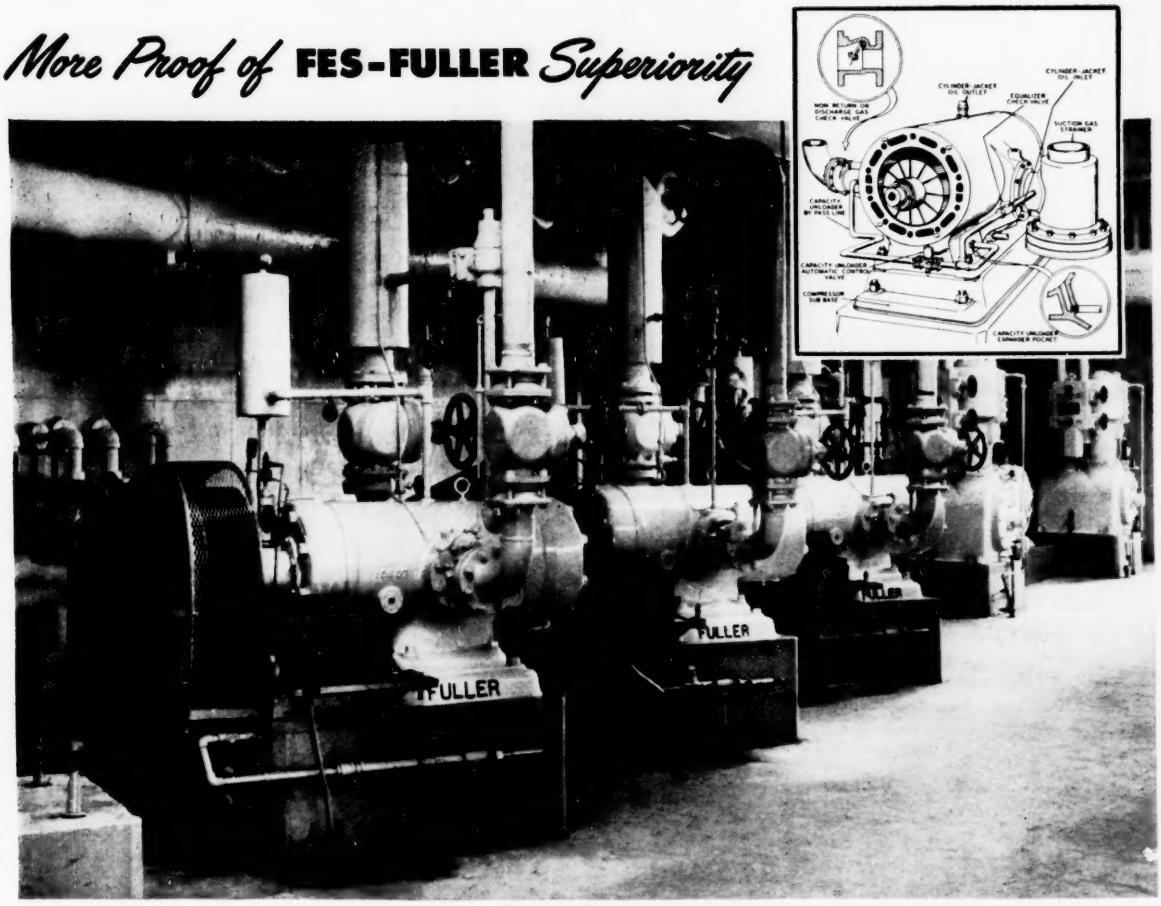

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NAPRE Question Box

HAVE A QUESTION? Address it to Prof. Harold P. Hayes, Dean of Engineering, State Polytechnic College, San Luis Obispo, Calif. Answers appear monthly in this department on problems forwarded by NAPRE members. Comments from all readers welcomed.

H. P. Hayes

Heat Calculations

QUESTION: How is the heat load figured for an open top refrigerated food display case; with gravity air circulation and, with forced convection?—Calif. No. 3, Sacramento.

ANSWER: Rather specialized treatment, based upon manufacturers test data and experience is involved in an answer. Chapters 12 and 13 1955-56 DESIGN VOLUME, and Chapter 33, pages 33-28 thru 33-31, 1956-57, APPLICATIONS VOLUME, of the ASRE DATA BOOK, will give the reader an idea of how extensive a proper reply should be. Some excellent data on the subject is available from Hussmann Refrigeration Inc., 2401 N. Leffingwell Av., St. Louis 6, Mo.

—H. P. Hayes

Checking Refrigerant Charge

QUESTION: Is there any sure way of determining whether or not a system has the correct amount of refrigerant charged into it? What happens if a system is overcharged or undercharged?—R.V., Green Bay.

ANSWER: Installation of a sight glass at the receiver, or in the liquid line at the point where it leaves the receiver, quickly saves its cost on multiple horsepower systems.

On a small system not equipped with a sight glass and without a receiver, excessive refrigerant charge will back up in the condenser, rendering a portion of it ineffective and raising the condensing temperature.

If the charge is not sufficient a mixture of liquid and hot gas will fill the liquid line making it warmer than usual. Also, whistling may sometimes be heard at the expansion valve. Evaporator temperatures will run from normal to high, while condensing temperatures will run from normal to low and cycling will be excessive.—**N.S., San Luis Obispo.**

Seeks Regulation on Compressor Relief Valves

QUESTION: Where may literature be located on sizing safety or relief valves for booster compressors or first stage compressors of multi-staged refrigeration systems. What should the pressure setting be? Where should the relief valve discharge and what precautions should be taken in the location of the discharge? Is there any code or standard in the industry which would cover this situation? R.H., R.K., and R.R., Chicago.

ANSWER: It seems that there is no standard method of sizing the relief valve for a booster compressor. However, a relief valve of "adequate" size is required by the American Standard Code for Mechanical Refrigeration, A.S.A. B9.1-1953, if this compressor has a discharge pressure above 15 psig.

Another answer from Chas. L. Whitaker, Engr'g. Dept., Air Conditioning and Machinery Div., Frick Co., advises:

"This department does not know of a code for sizing relief valves on compressors. Usual consideration is displacement of a compressor, providing a valve of sufficient size to cause a rise of not more than 10 percent in the compressor cylinder.

"The pressure setting should be at the maximum designed working pressure of the imposing element. This firm's practice is to connect the discharge from the relief valve into the main suction line ahead of the main suction stop valve on the imposing element.

"This division is not aware of any code or standard in the industry other than the general scope of the ASA B9 Code, which would cover this situation. There are quite a variety of requirements in various cities and states, and most suppliers usually refer to a cusomer's location and arrange connections accordingly."

From Leon Buehler, Jr., Chief Refrigerating Engineer, the Creamery Package Manufacturing Co:

"Pressure setting of this valve on the booster compressor would be up to the manufacturer and in relation to the design and strength of the compressor that is being protected. For example, if a high-stage ammonia compressor were converted to booster service, there's no reason why the relief valve setting need be changed.

"I know of no publication on the sizing of these valves on compressors, but should the questioner be thinking of protection for the intermediate pressure side of the system, this would normally be considered the 'low' side; and, the requirements of the ASA safety code would apply, based on the low side test pressure listed in the Code for the refrigerant in question."

Cites Specific Section From ASA Code

Section 12.2, B9 Code reads: "Pressure relief devices for positive displacement compressors. Positive displacement compressors operating above 15 lbs. per square inch gauge and having a displacement exceeding 50 cubic feet per minute shall be equipped by the manufacturer with a pressure relief device of adequate size and pressure setting to prevent rupture of the compressor, located between the compressor and stop valve on the discharge side. The discharge from such relief device may be vented to the atmosphere or into the low-pressure side of the system."

Other answers received from York Div., Borg-Warner Corp., from Brunner Div., Dunham-Bush, Inc., and other reciprocating booster compressor manufacturers were in the same nature.—**H. P. Hayes.**

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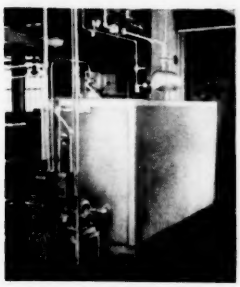

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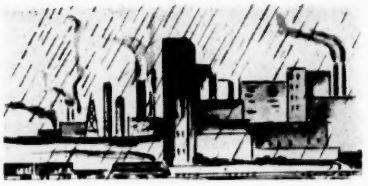

QUESTION: Ceiling of our meat (provisions) holding cooler is finished with a type of mineral cement (white) to 3/16 in. maximum thickness. This new addition was operated for three months then shut down one week for track leveling adjustments, during which period we left a 10 x 10 ft. 8 in. inter-connecting door open to sales cooler. Sales cooler was in continuous use.

When hold cooler was secured, condensation occurred on ceiling finish and metallic objects in room. It was not re-evaporated when room was placed back in operation. It has been a nuisance situation since, with water dripping over product and personnel. How do we remove the water with our existing evaporative surface?

Surface in this room 30 x 50 x 14 ft. consists of six ceiling hung units. The three arranged parallel and approximately 5 ft. from unit centerline to wall in which the large door is located, are rated 13,000 Btu/hr/10 F. TD.

Three 7500 Btu/hr/10 F TD units are similarly located from the opposite 50 ft. wall. The 13,000 Btu units circulate 2200 cfm. The 7500 Btu evaporators circulate 1200 cfm and all units circulate air continuously.

Air inlet is through opposite sides of unit and discharge is through circular opening in top and against circular metal diffusion plates which are approximately 9 in. away from ceiling. Coil air inlets face one another, that is, in a row of 13000 Btu units, inlets for 1st and 2nd units, and 2nd and 3rd, face one another.

Temperature of the room has been maintained by the units at 34 F, DB. Product turn-over is 48 hours. We have experienced no appreciable shrinkage so we believe humidity is adequate, but our insulation contractor and finish supplier believe that the humidity is excessive for the evaporative surface to do the added work of drying off the finish, track, rails and electric conduit.

In their opinion the units do a "sensible" job and the added moisture due to climatic conditions during the week's shut down is too much for the units at the 10 F TD. However, we have same type of equipment in the sales cooler and do not experience this condition even though it is open to shipping dock almost constantly during business hours.—FLK, Chicago.

ANSWER: Recent increase in humidity over that of the first three months period could only be caused by a decrease in temperature difference between that of the room air and the coil surface. It is probably due to a decrease in refrigeration load, which may be due to the winter weather.

It is not clear how the controls operate in this room; therefore, three possible methods will be considered:

1) **Temperature controlled by a thermostat operating a solenoid valve in a liquid line feeding all of the units.**

Under full load operation, when the thermostat calls for cooling, all units will operate at a full temperature difference removing moisture from the air and depositing it on the coils in the form of frost. Cooling will be required nearly continuously and frost will continue to form until defrosted. Under such operation the humidity will not be excessive.

Under reduced load operation, the frost will form on the coils when the solenoid is open but since this will be a relatively small part of the total time the frost will sublimate into the air stream when the solenoid is closed with little net removal of moisture from the room. Another way of looking at it is the mean temperature difference over an extended period of time is lessened and inadequate moisture is removed.

2) **Temperature controlled by a thermostat starting and stopping a single compressor.**

The operation in this case would be very similar to that of case (1).

3) **Temperature controlled by a thermostat operating a cylinder by-pass on a compressor.**

Under full load operation the operation would be similar to case (1); however on reduced load operation the temperature difference between the coil surface and the room air would decrease with a consequent increase in relative humidity.

Recommendation: In any case it would appear that there is more coil capacity than needed for present condition of operation. Therefore, it is suggested that one or more coils be shut off so that the remaining coils will need to operate at a greater temperature difference between the room air and the coil surface temperature.—**N.S., San Luis Obispo.**

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DOLE THE Cel LINE

Camp Refrigeration

QUESTION: I do a lot of camping and would like to build a portable refrigerator. Getting ice is so inconvenient that I would like to use bottled CO_2 or some other bottled gas. How can I figure my refrigeration capacity? S.J.A., Chicago.

ANSWER: To allow for the product load the infiltration and the transmission heat gain it is suggested that the total load be taken as three times the transmission gain.

Refrigerating effect of one pound of CO_2 will be the specific enthalpy of superheated CO_2 vapor at 41.7 psia and about 40 F, minus the specific enthalpy of saturated liquid at about 80° F:

$$162 - 74 = 88 \text{ Btu/lb.}$$

The CO_2 liquid can be relieved slowly into the box. However, care should be taken to relieve the CO_2 gas from the box to the atmosphere since concentrations gerater than 5% by volume in the car or camp habitat will cause fatigue.—**N.S., SLO, Cal.**

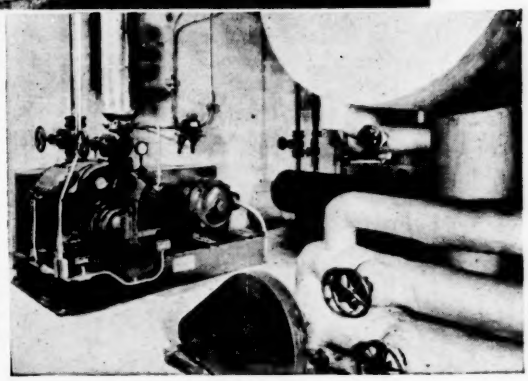
Do Home "Freezer" Cabinets Freeze Food Efficiently?

QUESTION: We are having an argument among our chapter members about home freezers. One group says that home freezers have adequate freezing capacity. The other side says cabinets and units are intended only to hold foods which are already frozen. Which side is correct? T.A.K., St. L., Mo.

ANSWER: Ability of any freezer to do a good job depends upon how close to the full load capacity the unit may be operating. The cabinet has a certain Btu removal capacity. When the freezer is nearly empty, most of the capacity can be used to freeze new items very quickly. If the freezer is filled to capacity, much of its Btu removal ability will be used to hold the products in the freezer. There will be much less "excess" freezing capacity.

Many engineers in the domestic freezer field personally follow the practice of buying already frozen items so that the load on their own freezers is lightened. (Indirectly, that is one point made in the TTT studies sponsored by TRRF at WURL, USDA Albany, Calif.—the consumer should buy his frozen foods well frozen and store them in his freezer at adequately low temperatures.) A good appraisal of how close to full load a freezer is operating can be made by observing the "on-off" running periods.—**H. P. Hayes.**

Borden's Dairy, Milwaukee, Wisconsin. View of trucks hooked up to a Vilter cold plate charging line. System is the recirculating type.



Interior view of the Borden plant showing Vilter 4-cylinder Ammonia VMC Compressor, recirculating pump, surge tank and receiver.

Another

Vilter Truck Cooling System!

Recently the Borden Company installed another completely automatic central station truck cooling operation in Milwaukee to provide refrigeration for 31 retail milk delivery trucks at a branch plant. Every effort was made by both Borden and Vilter to make this an outstandingly clean and efficient installation. The results are shown in the above two photos.

Each year more dairies are converting to hold over plate refrigerated milk trucks charged from the dairy's central station refrigeration system. These benefits accrue: Use of truck as a cold storage room, almost constant product temperature to the last delivery, more convenient loading for an early start, dry refrigeration. This central type system results in lower *first* costs, less maintenance, and guaranteed refrigeration, as compared to truck-mounted self-contained units.

If you are thinking about refrigerating your trucks, call in your Vilter representative, TODAY.

Write for these helpful bulletins to The Vilter Manufacturing Company
Dept. H-702, 2217 South First Street, Milwaukee 7, Wisconsin

Bulletin 734 Vilter Truck Charging Systems

Bulletin 617 Vilter VMC Ammonia Compressors

Bulletin 732 Vilter Evaporative Condensers

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New Questions

Grounds for Discussion

QUESTION: In our area we have a power supply from a three-phase 480 volt secondary. The secondary is not grounded. We show no voltage to ground from either conductor except varying voltage that may be due to induction between the conductor and conduit. The power company tells us this is quite normal.

Quoting from a recent article by a power engineer, "It must be realized that even on an underground 3-phase system there exists a normal voltage to ground, each phase which is 58 percent of line to line voltage.

Can you explain this discrepancy? —C.G., Bakersfield, Calif.

Understanding Oil Mixes

QUESTION: What is meant by the miscibility of oils? I see reference to this often, yet do not clearly understand what it is and why it is important?—D.W., Chicago.

X-ray Weld Inspections

QUESTION: Can you publish an x-ray picture of a weld and give some pointers on how to interpret? I know that weld inspection is becoming increasingly more important and would like to know how to read the pictures.—C.L., NYC.

Thermocouple To Thermistor

QUESTION: Someone told me recently that thermocouples are "old-fashioned" and that the latest thing is the thermistor. What is a thermistor and how does it work?—G.P., Los Angeles.

Selecting Pipe Materials

QUESTION: There are so many new piping materials on the market that it becomes more difficult to make a selection. Will you outline factors to consider in selecting materials for piping?—C.D., Pittsburgh, Pa.

News Notes and Chapter Activities

Jackson Chapter Readies For South Central Conference

JACKSON, MISS.—Preparations for the March 7, 8 and 9 Regional Conference at Jackson, Mississippi, has kept this newest Southern NAPRE chapter preoccupied. However, the chapter officers and members still find time to carry out their regular meetings and instruction courses. The chapter met on February 4 and January 21 as scheduled.

Two visitors at the chapter meeting were John Funel, Equitable Equipment Co. Inc. New Orleans, and Frank Vaughn, the Sporlan Valve Company representative from Birmingham, Ala. Funel is an active member of Louisiana No. 2 Chapter, NAPRE, and Vaughn was introduced as the chairman of the Birmingham section, ASRE. Funel was the speaker of the evening and presented a review of the products manufactured by the Vilter Manufacturing Co., Milwaukee.

The Municipal Refrigeration and Air Conditioning Code was the principal topic for the program portion of the January meeting. The chapter's board of Directors is in effect a special committee which works separately of the chapter affairs on making recommendations to the city concerning this ordinance.

Conference Program

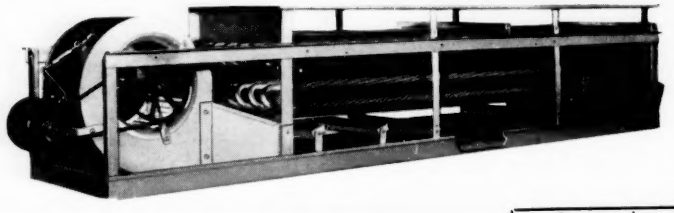
Tentative plans for the March Conference include four speaking presentations and a field trip. Registration will commence about mid-day on Friday, March 7, and extend through noon on Saturday. Two speakers will be presented on Friday afternoon and a welcome buffet will be the evening social activity. Following an official welcome by the Mayor of Jackson, Mississippi, conference attendants will make a tour of the Swift & Company plant. A luncheon will follow.

Afternoon schedule again calls for two speaker presentations followed by an informal dinner and social. Locale will be the Heidelberg Hotel for all convention events except the field trip. Post luncheon activity on Sunday, March 9, will be a chapter clinic. Adjournment will be mid-afternoon.—ROY H. STEWART.

Packers Arrange Schooling

GREEN BAY—After three years of effort, particularly a lot by the late Bert Bodart, Green Bay Chapter members finally arranged for a regular course of instruction. Regular sessions will begin January 15, 1958 and will continue until the end of the school year. Sessions will be held every two weeks at the Green Bay Vocational School. The chapter has an instructor with nine years of experience in this type of instruction. Members will use their own refrigeration books. Charges will be nominal.—JIM SCHOUTEN

COLDJET *Low Air Velocity* SPACE COOLERS



Cutaway shows 1" sealed-in cork insulation.

- Ceiling-suspended, saves space. (Fits between meat rails!)
- Gentle, quiet air movement eliminates drafts, adds to worker comfort.
- Cuts meat and other food shrinkage to a minimum.
- New design cuts installation and maintenance costs.

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NAPRE Members Prominent In Southwest Meet

NEW ORLEANS—Summarized reports and discussions from the Southwestern Ice Manufacturers' Association Conference for engineers last Fall showed that a large number of NAPRE members were very active in that organization. The summary itself, covering the 32nd Conference of Engineers, was prepared by R. A. O'Neill, Vice-president—engineering, Southern Texas Ice & Service, Inc., of Corpus Christi. O'Neill is a past national director of NAPRE. The material which follows was contained in O'Neill's report to the industry last Fall. Others appearing at the conference with presentations were Allan W. Cox, Toledo, Ohio; L. P. Reiss, Dallas; Obert K. Irvine, Dallas, and O. O. Roth, Harlingen, Texas.

Allan W. Cox, a member-at-large, NAPRE, Manager of Commercial, Light Industrial Insulation Sales Div., Owens-Corning Fiberglas discussed in detail the construction of the Pajaro Valley Cold Storage Plant located at Watsonville, California. The building contains approximately 28,000 square feet of floor area all on one level and is maintained at minus 15 F for storage of frozen food as a public storage warehouse. Most interesting was the new Angier Brown Skin Vapor Barrier paper.

Controls, Service, Safety

Semi-automatic controls were discussed by L. P. Reiss, who has always been one of the most active engineers in the Conference. L. P. Reiss described in detail the controls that he had recently placed in a plant which was changed over from steam operation to electric operation. Equipment which L. P. described was very simple and provided all of that necessary to adequately protect the system from excessive pressures, water failures and electric failures during the time that the plant is operating unattended. The equipment would also close the plant down when the desired temperatures had been reached. The equipment consisted of brine tank thermostat, water pressure switch, and high pressure cutout for each machine, and a solenoid operated shut off valve for the liquid ammonia.

Maintenance Theme

Obert K. Irvine of Southland Corporation is an officer of SWIMA as well as chairman of the technical committee which planned and carried out the San Antonio Conference. He covered preventive maintenance. His talk contained suggestions as to how to take a plant out of service for the winter months and then place this plant back in service during the summer operation with a minimum of expense, bringing out the fact that excessive maintenance of any compressor was caused by poor condensing conditions.

Ice Plant Safety was to have been the topic of Barney A. Majeskey, an officer of the NAPRE Chapter in Rio Grande Valley. However, he was unable to attend the Conference and O. O. Roth a member from Rio Grande Valley Chapter substituted for him. Roth explained in a very practical manner the workings of the Southern Texas Safety Program and in particular, the large plant at Harlingen. This plant will operate with a minimum of 11 employees to a maximum of 70 employees, which certainly embodies a problem on safety for the employees. The fact that this plant in particular, has not experienced a disabling accident in over 20 months, certainly indicates the kind of care with which new employees are selected and the manner in which they are trained by the older employees for their duties.—JOHN N. MARIAKIS.

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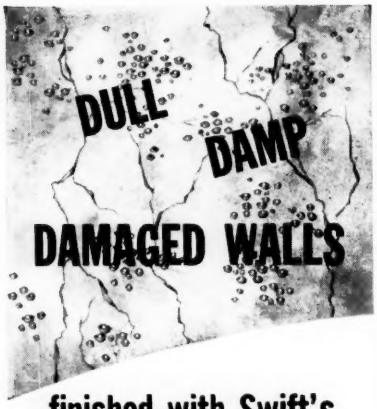

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JUST CLIP TO LETTERHEAD AND MAIL

Joint Ice Conventions Elect Officers

THE Missouri Valley, Oklahoma and Kansas Ice associations elected officers at the close of a three-day convention, January 21.

Harold Margolin of Kansas City was elected president of the Missouri Valley Assn.; Jake Waller, Wichita, president of the Kansas organization, and W. R. Addison, Tulsa, president of the Oklahoma group.

Other Missouri Valley officers: W. L. Butts, Joplin, vice president; Richard C. Muckerman, St. Louis, secretary-treasurer; and J. R. Dean, Cape Girardeau, M. J. Garvey, St. Joseph, Alvin D. Hatten, Indeepndence, and A. W. Gordon, Jr., Omaha, directors.

Other Kansas officers: Tom Carroll, Wichita, vice-president; Matt Scherer, Newton, secretary-treasurer, and Taylor Rowe, Saline, Lloyd Riggin, Topeka, and C. R. McCarter, Winfield, directors.

Other Oklahoma officers: Frank Robson, Claremore and Fred Simank, Stillwater, vice-presidents; Clyde Simmon, Oklahoma City, treasurer, and Harry T. Hudson, Oklahoma City, executive secretary and general counsel.

The meeting was well attended despite the 46-year record snowstorm which dumped 15 inches of snow on the area. Interest was excellent and the general attitude of the delegates was stimulating.

Brach Cites Savings Thru Warehouse Addition

NET sales of E. J. Brach & Sons set a record last year according to the company's annual report published at the close of the calendar year. Board chairman for this candy and confection manufacturing firm credited considerable savings during addition. The warehouse, started in 1956, was completed in 1958 with an expenditure of $672,348. Although the report credits savings in storage charges as a result of this construction, profits declined from the previous year.

Environmental Equipment Conference in April

SECOND annual meeting of the Institute of Environmental Engineers will be held April 17 and 18 at the Hotel New Yorker, New York City, according to Henry F. Sander, president. An equipment conference, sponsored by the Environmental Equipment Institute will be held simultaneously.

New ASHAE Officers

PRESIDENT of the American Society of Heating and Air-Conditioning Engineers is Elmer R. Queer, director and professor of engineering research, The Pennsylvania State University, University Park, Pa. Elected January 28, during the 64th Annual Meeting at the Penn-Sheraton Hotel, Pittsburgh, with Professor Queer, are First Vice-President, Arthur J. Hess, president of Hess-Greiner & Polland, Los Angeles, Calif.; Second Vice President, Walter A. Grant, vice president, Carrier Corporation, Syracuse, N. Y.; and Treasurer, John H. Fox, vice president—sales, Honeywell Controls, Ltd., Toronto, Ont., Canada.

New members of the Society Council, elected for 3 years, are Frank H. Faust, manager, product planning, Commercial and Industrial Air Conditioning Dept., General Electric Co., Bloomfield, N. J.; Fred Janssen, standards engineer, gas department, Public Service Company of Colorado, Denver, Colo.; James W. May, director of technical training, American Air Filter Co., Louisville, Ky.; and Gayle B. Priester, air conditioning engineer, Baltimore Gas and Electric Co., Baltimore, Md.

Elected for 3 years as members of the Society's Committee on Research are Paul R. Achenbach, chief, air conditioning, heating and refrigeration section, National Bureau of Standards, Washington, D. C.; Stanley F. Gilman, assistant director of research, research and development division, Carrier Corporation, Syracuse, N. Y.; Neil B. Hutcheon, assistant director, division of building research, National Research Council, Ottawa, Ont., Canada; Richard M. Stern, partner, Stern & Towne, Seattle, Wash.; Herbert E. Ziel, Albert Kahn Assoc., Architects and Engineers, Inc., Detroit, Mich.

Detroit Ice Rink Opened

FIVE 100 hp compressors are used in the new outdoor skating rink opened in Farwell Park, E. Outer Drive at Mound Road, Detroit. The layout incorporates a one-eighth mile speed skating track, hockey rink, general skating area, loudspeaker system, lights, and artificial lake with three illuminated fountain sprays, within an area 400 x 190 feet. The surface is kept at freezing temperatures by the circulation of 15,000 gal. calcium chloride brine through 35 miles of pipe. Adjoining the rink is a temporary building housing a warming room for skaters, concession stands, office, check room and guest rooms.

COMING CONVENTIONS

THE REFRIGERATION RESEARCH FOUNDATION
March 6-8, 1958
Adolphus Hotel, Dallas, Texas
H. C. Diehl, Director

NORTH CAROLINA ICE ASSOCIATION, INC.
March 9, 10, 11, 1958
Sir Walter Hotel, Raleigh, N. C.
Lewis H. Powell, Secy-Treas.

AMERICAN WAREHOUSEMEN'S ASSOCIATION
March 10-13, 1958
Adolphus Hotel, Dallas, Texas
Wm. Dalton, Secretary

NATIONAL ASSOCIATION REFRIGERATED WAREHOUSES
March 10-13, 1958
Adolphus Hotel, Dallas, Texas
Wm. Dalton, Executive Vice-Pres.

NORTHWEST ASSOCIATION OF ICE INDUSTRIES
March 13, 14, 1958
Davenport Hotel,
Spokane, Washington

VIRGINIA ICE MANUFACTURERS' ASSOCIATION
March 19, 20, 1958
Chamberlain Hotel
Old Point Comfort, Virginia

AMERICAN POWER CONFERENCE
March 26-28, 1958
Hotel Sherman, Chicago, Ill.
R. A. Budenholzer, Conference Director
3300 Federal St., Chicago 16, Ill.

MOUNTAIN STATES ASSOCIATION OF ICE INDUSTRIES
April 10-12, 1958
Hilton Hotel,
Albuquerque, New Mexico

CANADIAN WAREHOUSEMEN'S ASSOCIATION
May 12-15, 1958
Seigniory Club, Montebello, Quebec
H. Cecil Rhodes, Managing Director

Fire Fighters Rush to Small Cooler Fire

WHEN the refrigerator room at Wellington Fisher's slaughterhouse in Winfield, Pa., caught fire early one morning the countryside for miles around was aroused. While Fisher was putting in a call to Lewisburg for firemen, another man was contacting the telephone operator in Sunbury for help. The telephone operators in the two boroughs summoned firemen from seven communities to the fire, a small one, that was confined to the refrigerator room and an adjacent small building.

Ice Plant to Add Addition

THE Portland Ice & Cold Storage Company, Portland, Ore., has purchased a tract at the intersection of NW 17th Avenue and Therman Street, with a one-story aluminum frame warehouse building, from Western Door & Plywood. The company plans to build a plant addition on the site.

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Catalog 73
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News of PEOPLE

Railways Ice & Service Co. Personnel Changes

Leland Kenagy

WESTERN Refrigeration Co. and Railways Ice & Service Co., wholly owned subsidiaries of Southeastern Public Service Co., New York, announced in January the election of T. Otis Roberts, as vice-president in charge of cold storage operations, with headquarters in the Huron Building, 905 North 7th Street, Kansas City, Mo.

Roberts, in recent years, has been general manager of the Colorado Ice & Cold Storage Co., Denver. Southeastern Public Service Co. recently acquired the Colorado properties, merged it with the Utah Ice & Storage Co. and Montana Ice & Storage Co., forming a new corporation, Western Refrigeration Co. This new company is allied closely with the Railways Ice & Service Co. and have the same general office headquarters. Primary business of both companies is ice manufacture, railroad car icing and cold storage warehousing.

Estel W. Woodruff was appointed manager of Colorado Ice & Cold Storage Company in Denver, succeeding Mr. Roberts. Woodruff was formerly manager of the Argentine-Armourdale plant of Railways Ice & Service Company. New manager of the Argentine-Armourdale plant is Leland M. Kenagy, formerly chief engineer of the Railways Ice & Service properties in the Kansas City area. Kenagy is national treasurer of NAPRE.

Tressler Turns Back to Consulting and Editing

RESIGNING his position as Scientific Director of the Quartermaster Food and Container Institute for the Armed Forces, Chicago, Ill., Dr. Donald K. Tressler, has returned to his consulting practice. He is now Manager, Donald K. Tressler and Associates, with Laboratories on North Campo Road, Westport, Conn. He will also be Editor of the Avi Publishing Co., publishers of food technology books, also located in Westport.

Since 1950, Dr. Tressler has had charge of the food and container research and development program for the armed forces. Under his direction the food radiation and dehydration research work of the Institute has advanced rapidly. He is the author or co-author of several books, among them: *Marine Products of Commerce* (with J. M. Lemon), the *Freezing Preservation of Foods* (with C. F. Evers), *Into the Freezer–And Out* (with C. F. and B. H. Evers), and *The Chemistry and Technology of the Manufacture of Fruit and Vegetable Juices* (with M. A. Joslyn).

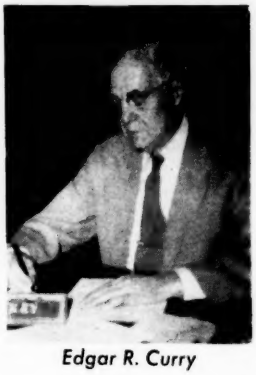
Tressler is a Fellow and Life Member of the American Society of Refrigerating Engineers and the American Public Health Association, and also a member and former councilor of the American Chemical Society and the Institute of Food Technologists.

After receiving his Ph.D. Degree at Cornell University in 1918, Dr. Tressler conducted researches on the preservation of fish and fishery products at the U. S. Bureau of Fisheries. While at the Mellon Institute of Industrial Research from 1920 to 1929, he invented a process of making liquid glue used by LePages for the past twenty-five years, discovered the high glutamic acid content of Steffens waste, patented a process of making monosodium glutamate from this waste, and also patented some methods of making synthetic waxes.

During 1929-33, he was chief chemist of the Birdseye Laboratories and helped Clarence Birdseye perfect the now well-known Birdseye Frosted Foods. From 1933-43 he was head of the Chemistry Department of the New York State (Geneva) Agricultural Experiment Station, and Professor of Food and Agricultural Chemistry in Cornell University. While in Geneva he perfected procedures now used in home freezing of foods.

Edgar R. Curry Retires

EDGAR R. CURRY has retired as Managing Editor of INDUSTRIAL REFRIGERATION. He has been with Nickerson & Collins Co., Publishers of INDUSTRIAL REFRIGERATION since 1927, as associate editor of *Ice and Refrigeration* and *Merchandising Ice* and as managing editor of INDUSTRIAL REFRIGERATION.



Edgar R. Curry

After more than 30 years and past retirement age, Curry says he is going to take it easy from now on. He and Mrs. Curry plan to move to a warmer climate some time before the snow flies in Chicago next winter.

His duties on INDUSTRIAL REFRIGERATION have been taken over by J. Richard Kelahan, Technical Editor since 1952.

DIMCO CAST ALUMINUM FIN EVAPORATING COIL

The Ideal Refrigeration Surface for Cold Storages, Freezer Plants, Dairy Products, Packing Houses, Abattoirs, Breweries and numerous applications

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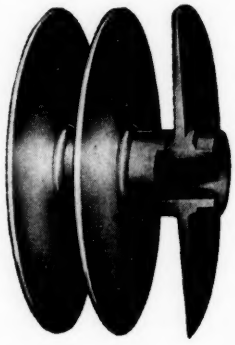

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MANUFACTURERS' NEWS

Anthony Schneider Named FES Project Engineer

Anthony Schneider

THE APPOINTMENT of Anthony Schneider as Project Engineer has been announced by Freezing Equipment Sales Inc., York, Pa. In his new position Mr. Schneider will direct and coordinate activities in new equipment development and design improvement. He will also supervise activities in the areas of contract engineering and equipment field application.

Before assuming his new position, Mr. Schneider spent three years as manager of the Test & Model Section of the York Division of Borg-Warner Corporation. In this capacity he was responsible for designing special testing equipment. He is a graduate of Pennsylvania State University where he received his Bachelor of Science degree in mechanical engineering. During World War II, he served in the Army Air Corps as a heavy bomber pilot, winning the DFC.

Kuehn Resigns Party Post

THE resignation of Philip G. Keuhn as chairman of Wisconsin's Republican party organization was announced recently at a press conference at GOP headquarters in Madison. Mr. Kuehn is president of the Wisconsin Cold Storage Company, Milwaukee. He was elected state chairman in 1953 and reelected last year. He said he had intended to resign last March but postponed his decision because of the special senatorial election in Wisconsin. He resigned because of "increased business pressure".

New Plant For Marlo

MARLO Coil Company has transferred its operations to a new plant and office building in south St. Louis. All manufacturing and administrative functions at the previous location in west St. Louis have been discontinued, and the property sold. The entire moving operation was accomplished without loss of production or services, according to a release by the firm in January.

The new plant has been equipped with specially designed machinery for product fabrication, arranged for straight-through production flow. The entire structure is air conditioned with newly-developed Marlo roof-top units for heating and cooling. The new facility is a modern one-story building, with 120,000 square feet of office and production area. It was completed in two stages. The first unit, for manufacturing only, began operation in 1954. Further expansion plans include the addition of a third unit.

Marlo Coil Company manufactures a complete line of air conditioning and heat transfer equipment for industrial, commercial and residential applications, including central station units, remote room units, cooling towers, evaporative condensers, heating and cooling coils, industrial coolers and low temperature units.

Baltimore Aircoil 20th Anniversary

OPEN HOUSE on Saturday, February 1, was held by Baltimore Aircoil Company, Inc., on the occasion of the firm's 20th anniversary. Industry figures, customers and suppliers were given informal tours of the firm's new plant located on the B & O Railroad between U. S. Route 1 and the Baltimore-Washington Expressway, a few minutes out of Baltimore, Maryland. The new plant, in operation in December 1956, replaced earlier structures in Baltimore.

Vilter Promotions

THE VILTER Manufacturing Company Milwaukee, Wis. announces the promotion of Whitney I. Grant to the position of assistant chief engineer and Rolf Boehm to the newly created position of contracting co-ordinator.

Whitney I. Grant

Rolf Boehm

In his new position, Mr. Grant will report to Mr. E. J. Kocher, chief engineer. He graduated from the Marquette University School of Engineering in 1949, joined The Vilter Manufacturing Company on February 7, 1950 and served in various capacities as plant engineer, assistant to the president, manager of the price and data department, and as assistant to the chief engineer.

As Contracting Co-ordinator, Mr. Boehm will report directly to A. A. Silverman, president. He graduated from Marquette University in 1942 with a degree of B.E.E., and also received the degree of B.M.E. from Marquette in 1947. He joined The Vilter Manufacturing Company in 1951 and served in various capacities in the Engineering Department, including the post of Manager of Research and Development.

New Agent Appointed

VALCOUR Chemical Company, has been appointed as agent by Nitrogen Division, Allied Chemical & Dye Corporation to handle sales for Barrett Brand Anhydrous Ammonia in cylinders in Vermont and adjacent New York counties, says an announcement from Allied Chemical. Valcour Chemical Company will stock cylinders at its South Champlain Street location in Burlington, Vermont.

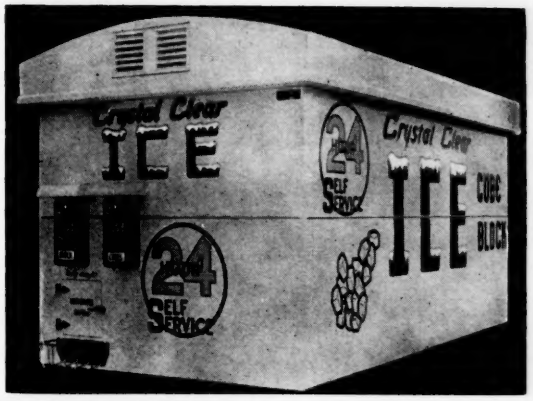
K. G. BROWN INTRODUCES THE NEW MULTI SCREW VENDOR FOR 1958

- **An increased capacity of 40% over previous models.**
- **Multi Single Line Vending of any size package or block, regardless of the type of tie.**
- **These new vendors are now made in lengths up to 20' which will vend 268 10# bags plus 132-25# blocks out of the same delivery door, (400 Sales).**
- **Up to 5 various sizes of blocks or bags can be vended from this one vendor.**
- **Radical invention, trouble free, more storage space by design, lower operational cost.**

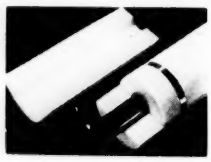
NEW LOW COST 6' x 8' station vends 110-10# packages, or the "Junior", 3' x 7' station vends 90-10# packages using the new multi screw vendor.

ILLUSTRATED
9' x 16' Station vends 168-10# bags and 86-25# block.

K. G. BROWN MFG. CO., INC., MATTITUCK, N. Y.



Here's Real News In Pipe Covering by Glo-Brite!



GLO-BRITE STYROFOAM*
PIPE COVERING

for all low temperature and cold water line pipe covering. All sizes from ⅛" thru 16" pipe & tubing. Perfect Vapor Barrier. Quick, easy to apply. 36" lengths—featherlight. No outer covering needed.
* ®

See your distributor, or write,

glo-brite PRODUCTS
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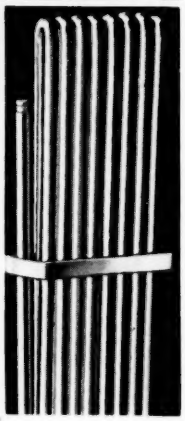
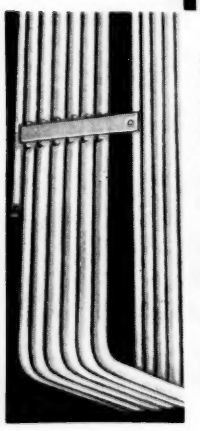
PIPE BENDS
COILS, HEADERS AND FABRICATIONS...

the tougher the job, the better our expert metalworkers like it. With their modern equipment, they produce the finest work to your precise specifications. In





any metal, even stainless steel, or up to 6-inch extra heavy. For fast, quality bends, backed by nearly 40 years specialization, call on us! **May we quote on your next job?**

CHICAGO NIPPLE & MFG. CO.
1997 Clybourn
Chicago 14

Wells Joins Ideal Electric

APPOINTMENT of J. Arthur Wells as representative in Northern California for The Ideal Electric and Manufacturing Company was made recently. Wells, with 11 years in sales and application engineering for all types of industries, is well qualified in refrigerating and air conditioning electrical problems. His firm, Apex Engineering & Sales Co., has headquarters in San Francisco on Bay Shore Boulevard, and a branch office at San Jose.

Wells was graduated from the University of California Electrical Engineering School in 1941 and has completed the University Extension Course in Business Administration for Technical Personnel. He is a registered Electrical Engineer in the State of California and held a license as chief engineer of steam and internal combustion engine vessels. Wells is a member of NAPRE, AIEE, the California Society of Professional Engineers, the Pacific Coast Electrical Association, the San Jose Engineers Club, the Peninsula WaterWorks Association.

American Air Filter Moves To Acquire Kennard

KENNARD CORP. stock will be acquired by American Air Filter Company, Inc., Louisville, Kentucky, subject to certain conditions to be effected early in the year. Kennard Corp., a St. Louis firm, manufactures heating and cooling coils, ventilating, heating and cooling equipment. According to AAF officers, the St. Louis firm would be operated as a wholly owned subsidiary.

CATALOGS AND BULLETINS

Recold Multizone Catalog

A NEW 28-page catalog (55C7c) on Recold's "Multizone" air-conditioning units has been issued to supersede the present catalog (55C6a). Featuring eighteen pages of performance data, the catalog covers the entire range of sizes from MZH-33 (1650 cfm) to MZH-580 (34,000 cfm), plus added information on changes in the Units which were not available in the previous catalog.

The tables show coil performance ranging from 400 fpm to 600 fpm face velocity at six different conditions for chill water and direct-expansion; and three different conditions for hot water and steam conditions. Also in this grouping is static pressure data on coils, filters and zone dampers; along with fan performance, giving full details for a particular unit.

New information in the catalog includes: Descriptions of Recold's method of mounting the filter section on top of the unit to conserve space, and locating the possible split section in the blower housing; information that Recold's "Mulizone" units are available with Class I forward curved wheels to handle statics up to 3½ inches, and backward curved wheels for statics up to six inches.

Protective Coatings Manual

A NEW thirty-six page protective coatings manual has been released by the Rust-Oleum Corporation, 2799 Oakton Street, Evanston, Ill. It feaures actual color chips of 102 different coating items and includes complete sections devoted to methods of surface preparation, use of primers, and finish coatings, and the availability of special custom coatings where required. Sections of the manual include primers, short oil type coatings, long oil type coatings, restful color group, oil field finishes, heat resistant and chemical resistant coatings, galvinoleum coatings, floor coatings, and other specialized maintenance products.

VAN RENSSELAER
H. GREENE
ENGINEERS

COMPLETE PLANT DESIGNS INCLUDING BUILDING AND EQUIPMENT

11 PARK PLACE NEW YORK 7, N. Y.

Bulletin on Dean Thermo-Panel Coils

A VALUABLE bulletin for users of pipe coils is announced by the Dean Thermo-Panel Coil Div. of Dean Products Inc. Brooklyn, N. Y. The Dean Thermo-Panel Coil is not a pipe coil in the usual sense. It takes the place of pipe coils for industrial heating and cooling processes and is claimed to do a better job. Two metal plates are embossed and then welded together to form flow channels as shown in numerous illustrations. The bulletin gives both design and price information. It also tells how to do individual estimating. The coil is made of a wide variety of metals.

Antwerp Refrigerators Speed Food Movement

NEW refrigeration facilities added to the part installations at Antwerp, Holland, permit quicker loading and unloading of vessels and also make possible a more satisfactory handling of perishable goods. In addition to the new depots on quay 123 which the "Institute of London Underwriters" has classified in group one and which are regularly controlled by engineers from "Lloyd's Register of Shipping", modernization work is now proceeding on quay 121, where refrigeration installations date back to 1920.

Measuring 317 ft. long and 193 ft. wide the facilities on quay 123 extend over three levels, each accessible on foot. The cold rooms are 50 x 144 ft. There are 18 altogether, and the aggregate storage space is in excess of 1,000,000 cu. ft. The temperature in all rooms can be kept at zero F. Part of the depot can also have a temperature of minus six degrees F. For cold rooms on the second floor a constant temperature of 32 F can be achieved. Work now proceeding on quay 121 will add further facilities, especially for deep frozen meat. The 14 former cold rooms will be replaced by three big ones each about 200,000 cu. ft.

Port officials claim that these new facilities have greatly speeded up the handling of such items as vegetables, fruit, meat, fish, butter and eggs and other perishables which pass through Antwerp in large volume. Not long ago, for instance, it was possible to unload 3,000 tons of frozen meat in less than 33 working hours, including the weighing, packing and dispatching of the goods. This was all the more remarkable as there were 70 different brands of meat, all requiring special handling.

CYCLE CENTER

SUBCOOLED LIQUID FEED AT CONSTANT PRESSURE AND AT SUCTION TEMPERATURE

For any refrigerant. Feed pressure adjustable.

INCLUDES COMPRESSOR PROTECTION.

You will profit by reading Bulletin CC-1 which gives complete data on the Cycle Center. It contains a valuable power savings chart, gives system diagrams and presents additional advantages.

WATKINS PRESSURIZED PLANTS

Manufacturers of: Recirculators, "Coli-Flo" Hand Expansion Valves, "Tell Tale" Solenoid Valves, Atmospheric Spray Evaporative Condensers, Purgers, Freezer Evaporators, Hot Gas Defrosting Systems.

J. E. WATKINS CO.,
Maywood, Illinois

Classified Advertising

All classified advertisements are payable in advance. Except for Positions and Help Wanted classifications, this section is reserved exclusively for USED equipment.

RATES: 20c per word; minimum 25 words. $2.00 per line for bold face headings; $15.00 per inch for line listings.

Position and Help Wanted

WANTED: experienced sales engineer; salary and expenses. Contact Central Ice Machine Company, 5014 South 24th St., Omaha 7, Nebr., Phone Market 4690.

WANTED—We have an opening for a refrigeration and boiler engineer. Must have ability to operate and maintain high and low pressure ammonia equipment. Chief responsibilities are quality control of frozen turkeys, maintenance and operation of refrigeration equipment. Apply to P.O. Box 436, Gibbon, Nebr.

USED EQUIPMENT—wanted & for sale

FOR SALE — Complete 15 ton Frick Ice Plant, erected new 1947. Good condition; $6,000.00 f.o.b. cars North Carolina. Born Co., 80 East Jackson Blvd., Chicago 4, Ill. WAbash 2-3299

FOR SALE — 9x9 Frick (factory rebuilt 1956); D.C. motor (rewired 1956); new Westinghouse starter switch & good AC-DC set. A real buy! Priced right. Media Fuel & Supply Co., 523 South Ave., Media, Penna. LOwell 6-0570.

FOR SALE—One 8 x 8 and one 6 x 6 high speed ammonia compressors. The Gus A. Regnier Refrigerating Engineering Co., P. O. Box 1093 New Haven, Conn.

FOR SALE — Refrigeration equipment; ice equipment; new, used. Advise us your needs. **Use "QUICKSEAL"** — stops brine tank leaks; easy, efficient, economical. Born Company, 80 East Jackson Boulevard, Chicago 4, Illinois. WAbash 2-3299

FOR QUICK SALE

Special Offering Subject Prior Sale

Complete 12 can pull, 70 ton ice plant, maintained in top condition. Can be seen in Operation. Owner wishes to retire. Asks $12,000. f.o.b. middlewest, this includes dismantling and loading. Plant is near water. Can be loaded on barge for cheap freight. Born Company, 80 E. Jackson Blvd., Chicago 4, Ill. WAbash 2-3299.

FOR SALE—8 x 8 York, overhauled, $350.00. One 20" x 10 ft. receiver. Valves up to 2", 1/2 price. Write E. Niehling, 1546 St. Clair Ave., Mt. Healthy, Cincinnati 31, Ohio.

AMAZING INCREASES in performance reported by users when they install new Ball Valves which are advertised on page 8 of this issue.

FOR SALE

10 x 10 York Model D8 125 h.p.
9 x 9 York duplex Model D8 360 r.p.m., 200 h.p.
10 x 7½ and 8 x 6 York Model D8 boosters.
7½ x 7½ York w/V-belt drive 50 h.p. motor.
300 h.p. Westinghouse starter 4160 volts (new)
100 h.p. 1200 r.p.m. GE motor w/starter.
(2) 6 x 6 Yorks V-belt drive, 25 h.p.

JOHN F. CARSON
A & Venango Sts. Philadelphia 34, Pa.
GArfield 6-2221

FOR SALE—5000 lb. Vogt ice machine. Good as new, Emerson McNeil, 1001 Torrey Bldg., Duluth, Minn.

FOR SALE—2 International water softeners, filters and tanks, J-22. One 8 x 8 York Compressor, late model. All A-1 condition. Make offer. Adrian Ice Co., 317 W. Maple, Adrian, Mich.

FOR SALE—AMMONIA

4—10"x10" 4-cyl. York duplex D. C. to 225 h.p. motor.
2—10"x10" 2-cyl. York D.C. to 100 h.p. motor.
1—9"x9" 2-cyl. York D. C. to 75 h.p. motor.
4—9"x9" 2 cyl. Frick compressors.
1—7¾"x5" Frick booster.
2—7½"x7½" 2-cyl. York compressors.
1—5¼"x4¼" 6cyl. V/W York booster compressor.
1—5"x5" 2-cyl. York compressor.
1—3"x3", 1—4"x4", 2—5"x5 condensing units.
11"x22"x47"—11"x22"x51 ice cans.
From 20 to 100 ton ice plants, York & Frick.

ENTERPRISE EQUIPMENT CORPORATION
79 Alexander St. Box 502 Yonkers, N. Y.
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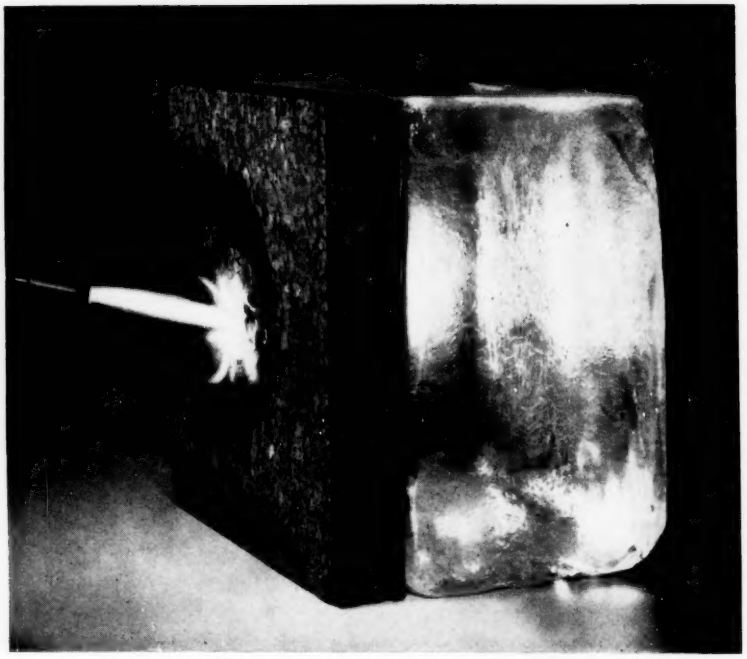
QUICK RESULTS with Classified Ads



Why United's patented process results in corkboard of higher insulating value

Cork in its natural state is well known and highly regarded as an excellent insulating material. However, by an exclusive blocked-baked patented process that combines *both* external and internal heat in the moulding operation, United BB Corkboard is unsurpassed in insulating value.

Further, United Corkboard is 100% cork . . . with no filler added, and, its high strength in relation to light weight permits a sturdy self-supporting structure that is simple to erect. It's flexible too . . . fits accurately, works as easily as lumber and the natural resins released during processing further add to its excellent moisture resistant characteristics.

The next time you have a need for low temperature insulation investigate the unique combination of benefits only "patented process" United Corkboard can provide.

Write today for specifications and helpful installation data. No obligation.

UNITED BB CORKBOARD

UNITED CORK COMPANIES

Since 1907

4 Central Avenue, Kearny, New Jersey

ENGINEERING AND INSTALLATION SERVICE — to meet your individual requirement . . . insure the most effective use and provide proper installation, United maintains fifteen branches throughout the country, staffed with experienced engineers and installation crews. For the one nearest you simply write our Kearny address.

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NO RUST—

G-W
CORROSION-RESISTANT BREAKER-ELEVATOR GIVES
ALL-CLEAN ICE ALL THE TIME

MORE PROFIT
NO RUST = NO WASTE

The Whole Cake is Saleable

Clear, *clean ice* from all of every cake — that's what you count on to keep profits from melting. And more profit is what you get with the G-W Breaker-Elevator — because every part of it is corrosion-resistant.

Breaker and elevator casing, breaker plates, shafting, flights, sprockets are aluminum alloy or stainless steel. Even after this G-W Breaker has been standing idle, ice particles emerge rust-free and usable.

Corrosion-resisting isn't the only feature of the G-W Breaker-Elevator that was planned with your profit in mind. Snow ice and fines are reduced to a minimum because the *curved picks* strike the cake at right angles, imitating the slicing feed action of hand shaving. Particles are passed without additional crushing through the *comb plate* because the *breaker drum* is ribbed. Flow is steady, discharge is even because drop is minimized and *elevator flights* are close-spaced. A single motor drives both breaker and elevator.

Stop profit-loss where it can be biggest—in your ice breaker. Any G-W representative can tell you about this new profit-building, corrosion-resistant breaker, and recommend a unit size to fit your exact needs.

GIFFORD-WOOD CO.

Hudson, N. Y.

420 Lexington Ave., New York 17, N. Y. • 3537 Lee Road, Cleveland 20, Ohio
Railway Exchange Bldg., St. Louis 1, Mo. • 565 W. Washington St., Chicago 6, Ill.

Pacific Coast Representative: WESTERN ICE EQUIPMENT CO., 420 Market St., San Francisco 11, Calif.

1447

SPECIFICATIONS

BREAKER	ELEVATOR
Stainless Clad Steel Plates	Aluminum Alloy Casing
Metallized Rustless Drum	Aluminum Alloy Flights
Chrome-Plated Picks	Stainless Steel Shafting
Chrome-Plated Bolts	Stainless Steel Sprockets
Shear Pin Protected Hubs	Chrome-Plated Steel Chain

Cuber | Tiering Machine | Conveyor | Breaker

HEADQUARTERS FOR ICE HANDLING, CUBING AND SIZING MACHINES AND TOOLS

Jamison announces flexidor*...

NEW flexible batten door

All-neoprene batten door designed for use with power trucks

Flexidor is light and resilient to absorb and dissipate the shock of impact; reinforced door noses add strength, prevent buckling or wrap around on impact. Free-swinging door suspension provides minimum impact resistance. Jamison two-way gravity cam hinges assure fast closing.

Flexidor is available in a full range of sizes for use in new construction or to replace rigid battens. Complete information is available from the Jamison Cold Storage Door Co., Hagerstown, Md.

JAMISON

COLD STORAGE DOORS